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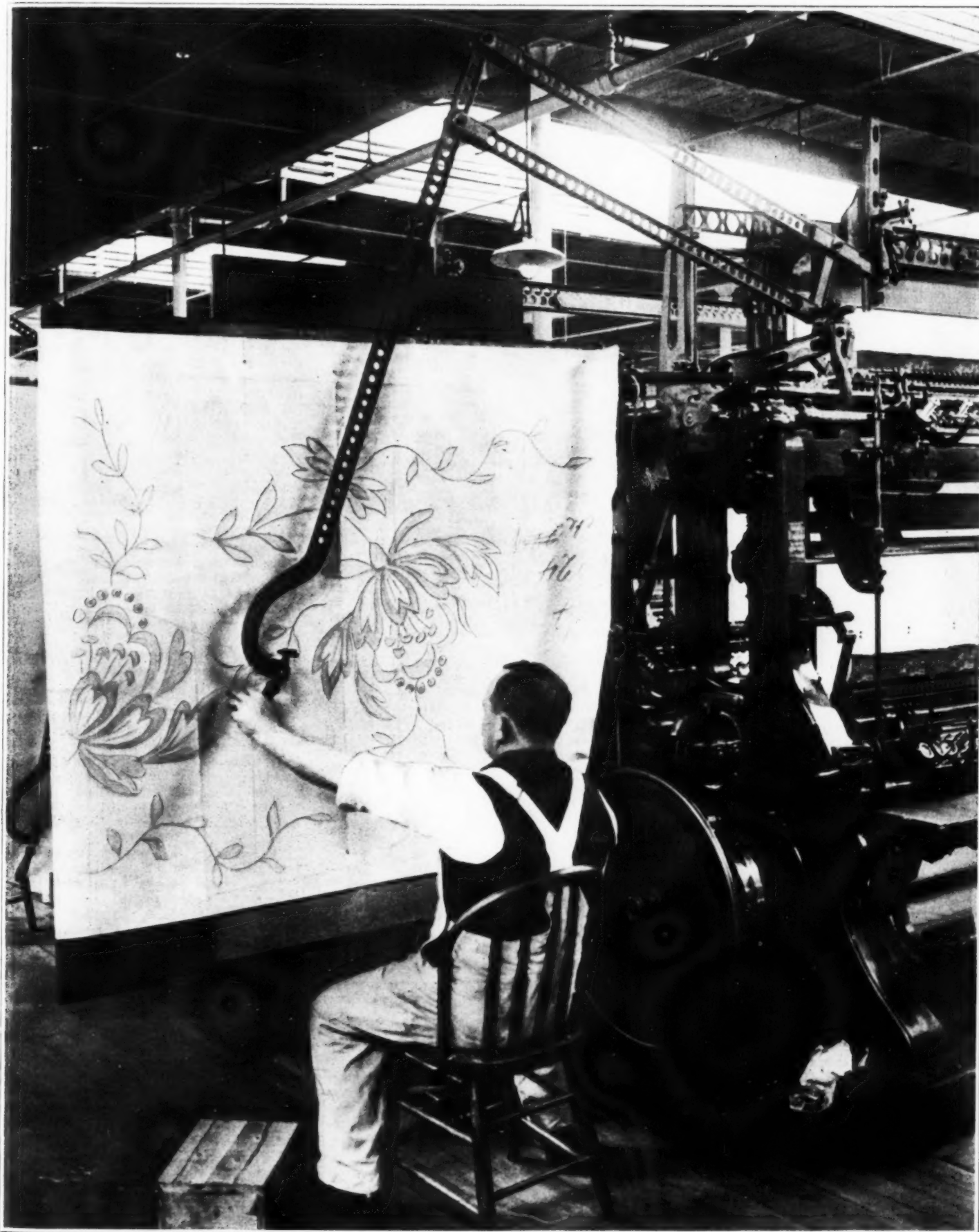
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Controlling the operation of the machine by means of a Pantograph
EMBROIDERY BY WHOLESALE [See page 116]

The Chemistry of Flavoring Matters—I*

The Relationship Between the Constitution of a Body and Its Taste

By Francois Barral, of the University of Paris, and Albert Ranc, Laureate of the Institute

SUBSTANCES possessing flavor when placed in the mouth, or to speak with more precision, when brought into contact with the mucous membrane of the tongue, produce a sensation which is known as a "taste." While this fact is one of common and daily experience it is highly complicated in nature, for what is commonly called a taste is not a simple gustatory sensation. Besides those impressions which cause the functioning of the apparatus belonging to the sense of taste, it is possible to note upon the surface of the tongue excitations of various sorts, which give rise either to purely tactile sensation or to sensations of heat or of pain. Moreover, since the mouth, which is an organ of many functions, is directly connected with the olfactory apparatus, the excitation of taste is nearly always accompanied by an excitation of the cells of the pituitary membrane, since it is these which are the organs affected by the action of odorous bodies. Hence the perception of a taste seems to be due to the composite functioning of three senses: taste, touch, and smell.

A minute analysis of this ensemble would appear to be impossible. It is not without great difficulty, in fact, that we have succeeded in classifying the different tastes. If, from the totality of sensation produced by the introduction of a savory substance into the mouth, we eliminate the sensations of heat or coolness, of pain if it is present, and of acidity or astringence, which are themselves complexes of thermic and tactile sensations, and if we suppress the operation of the olfactory sense¹ we find that the true flavors, or gustatory sensations, are really very few in number. The accepted view among the majority of psycho-physiologists is that there are four sorts of elementary gustatory sensations: the sweet or sugary taste, the bitter taste, the acid taste and the salty taste. These elementary sensations may be either strong or feeble, may be mingled in all proportions and may be united with other sensations to constitute the complexes which are commonly called tastes in ordinary language, but they, themselves, are invariable. The dozen flavors enumerated by Haller: insipid, sweet, bitter, acid, harsh, acrid, urinous, spirituous, aromatic, nauseous, putrid, to mention only one of the old classifications, can be reduced in the last analysis to the four elementary tastes given above.² As regards the sense of smell, the number of specific olfactory sensations appears to be in agreement with the variety of odorous substances; but when we come to the sense of taste, the great simplification which has been effected by the deeper knowledge which we possess of the physiological phenomena of gustation, has shown the poverty of this sense in comparison with the multiplicity of the substances which are capable of affecting it. How can we explain this characteristic of great generality possessed by each of the elementary tastes? Is it due to the fact that the gustatory apparatus lacks delicacy and precision in its method of functioning, or does it betray the hitherto unsuspected existence of new general properties belonging to substances? The combined efforts of chemistry and physiology have not yet enabled us to determine the immediate causes of the observed facts; and among compounds possessing an identical flavor, whose number increases daily, thanks to the progress in chemical synthesis, there have not, as yet, been found sufficient analogies of composition or of constitution to enable us to establish the law governing their action upon the sensory cells concerning the sense of taste. The chemistry of the sugary flavor in particular is far less developed than is the social importance of its object.

In all ages mankind has been occupied in the search for and the manufacture of substances capable of producing a sweet taste. The cultivation of sugar cane which has been carried on for three centuries in the colonies of the New World, and later the exploitation of the native sugar beet, have permitted the use of saccharose to be enormously extended in Europe. This substance which was scarcely known at all in France

in the time of Louis XIII has become today a product of prime necessity. Sugar is the universal condiment which spoils nothing, said Brillat Savarin, and it must be admitted today that it is almost impossible to dispense with its use. When the importation and manufacture of sugar were cut down during the war, it was necessary to make efforts to replace not only the actual potential food represented by the deficient saccharose, but also to supply the sugary flavor which our palates are accustomed to. Recourse was obliged to be had, therefore, to artificial flavors hitherto interdicted in France, chiefly for fiscal reasons.

The common sensations provoked by the stimulation of sensory areas are always complexes, from which the true sensations can always be extracted, as we have shown in the case of taste. The words color, odor, sound, flavor, pain, heat designate elementary sensations which we never observe singly, but which always form part of an ensemble which constitutes the common sensations, but which we isolate by experiment and reasoning power.

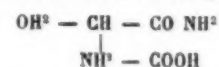
Subjective analysis carried still further leads us to regard elementary sensations as themselves consisting of an association of simple indivisible elements, capable of quantitative variations but definitely fixed qualitatively. As we make reduction after reduction it becomes evident that the sensation is the primordial internal element of knowledge. We possess no data as to its nature but the conditions under which its functions are definitely known. While we do not know the actual nature of the discontinuous mental phenomenon through which we obtain, fixed in our own brains by adaptation, a knowledge of the discontinuity of external physical phenomena, we are able on the other hand to follow the path of the nerve impulse, which, when set in action by external forces, stimulates one point or another in the upper areas of the brain.

The general process of the formation of sensations is as follows: The stimulus affects the sensory apparatus causing an excitation which is transmitted from the periphery to the nerve centres where it produces a sensation, which as Taine³ has said, is the mental representative and internal sign of the external fact which produced it. It is now believed that the numerous cells situated along the path followed by such an excitation, all have a special rôle, and that the transmission is accompanied by concomitant modifications. However this may be, the initial fact necessary to the formation of the sensation is the excitation of a sensory apparatus. In the case of the sense of taste the excitation must affect the gustatory papillae of the mucous membrane of the tongue. A substance cannot be tasted, i. e., it cannot cause a sensation of flavor, unless by reason of its solubility in the liquids of the mouth it is enabled to come in contact with the sensory anatomical elements of the tongue⁴. It is at this point that a soluble substance can exhibit its characteristic of flavor by taking part in the chemical or physico-chemical reaction which immediately precedes the functioning of the sense of taste. This conception appears to be definitely established; in the case of salty and of acid tastes at least it has been the subject of precise experimental verification.

E. Gley and C. H. Richet⁵, in studying the action of the salts of the different metals of the first group upon the papillae of taste, have shown that this action is identical for the same number of molecules, which tends to confirm the opinion that the gustatory stimulus operates according to the same laws that govern chemical action. Basing his view upon the works of Hoerber and Klesov and the long and important researches of Herlitzka, Languier des Bancels is of opinion that "the characteristic taste of a salt must result from the association or the conflict of the elementary tastes which are governed by the anions on the one hand, and by the cations on the other."⁶ But while it seems to be proved that the presence of hydrogen ions is the cause of the acid taste, and that the salty taste is produced by certain anions, it has been found that the sweet and bitter tastes are produced by a very considerable number of very different substances. The attempts made to establish relationships between

the constitution of a body and its taste have not yet yielded general results in the case of the sweet or the bitter tastes. Chemistry and psycho-physiology are still far from having the experimental elements necessary for the elaboration of a fundamental principle with regard to acid and to salty tastes in spite of certain interesting discoveries along this line.

In 1886 Plutti⁷ pointed out a relation existing between the structure of an organic body and its taste. This observation, the first one made in this category of research concerned a case of stereo or position isomerism. The two asparagines, the levo and the dextro, which are found combined or separated in the cell sap of many plants, and which can be obtained by doubling by means of simple crystallization synthetic racemic asparagine, exhibit in fact a curious peculiarity, name-



ly, the levo-asparagine is tasteless while the dextro-asparagine is sweet.

Pasteur, who made a report upon the researches of Plutti, drew the attention of the scientific world to this new observation, saying: "What is the reason for this great difference in taste between the two asparagines? Possibly we might suppose the existence of a special sort of isomerism. I am inclined to believe, on the contrary, that this physiological fact should be connected with that other fact that while two bodies which are inversely dissymmetrical exhibit in their combination with inert bodies physical and chemical properties which are absolutely similar, and even identical, these same bodies of inverse dissymmetry will yield combinations with entirely different properties when they are combined with bodies which are themselves dissymmetrical and which act upon polarized light. The dissymmetrical active body which intervenes in the nervous impression revealed by a sweet taste in one case, and an almost insipid taste in the other can be nothing other in my opinion, than the nervous matter itself, which is a dissymmetrical substance, as are all the primordial substances concerned in life: albumen, fibrin, gelatine," etc. Pasteur added that he was greatly in hopes that the research for similar peculiarities of equally great importance would thenceforward be made in systematic fashion. These hopes have not been realized, for we are obliged to confess the non-existence, at least in the French language, of any treatise upon substances having taste analogous to the works which describe the preparation and the properties of coloring matters and of odorous products. So far as we know the only complete exposition of questions relating to the chemistry of taste is contained in the work by G. Cohn,⁸ which appeared at Berlin in March, 1914. It will be worth while, perhaps, therefore, to make an abstract of the various documents concerning the study of the substances which affect the sense of taste,⁹ paying special attention to the chemical conditions which cause the appearance of the sweet taste.

The four chief tastes are found among the organoleptic characters of the bodies studied and classified in the chemistry of minerals. The property of producing a salty taste belongs to salts, but this occurs in a manner which is sometimes very different. While it is true that neither any acid or any base is salty, it is not in exact accordance with truth to think that none of them can be either sweet or bitter. The bitterness of magnesium salts is well known. The ionic sapidity of the ions Be, Al, Y, La, Zr, Ce, Cr (chromo-ion), Zn, Cd, Pb is sweet.¹⁰ The most salty salts are those yielded by non-oxygenated acids with monovalent bases, and the least salty are produced by oxygenated acids acting upon divalent bases. The acids owe their taste to hydrogen ions; as for the bases, which upon dilution take part in the operation of gustation, they all exhibit a sweet taste which appears to be connected with the degree of concentration of hydroxyl ions.¹¹ Generally speaking, if we refer to Mendeleff's classification we observe that in the first group all the cations are

*From *Revue Scientifique*.

¹The fragrant vapors proceeding from bodies placed in the mouth can no longer excite the sense of smell if by closing the nostrils one prevents the passage of the current of expired air which normally draws them into the nasal fossae. This is called Chevreul's experiment, but according to Languier des Bancels (*Taste and Smell*, Paris, 1912) we owe it to Cloquet who described it in 1821 in his *Osmosologie*.

²Oehrwall (*Scandinavian Arch. of Physiology*, 2, 1, p. 15) says, speaking of images, that the spectrum of taste is discontinuous—that it exhibits four isolated radii between which it is not possible to imagine a continuous series of intermediates. L. d. Bancels (*loc. cit.*).

³Taine. *On Intelligence*, Vol. I, p. 235. Hachette.

⁴Graham observed that crystalline substances always have taste, while the colloids, which yield only "false solutions" in water, are particularly insipid. (Cited by Bain: *The Senses and the Intelligence*. Alcan.)

⁵E. Gley and Ch. Richet. *Chem. Action and Gustatory Sensibility*. C. R. Soc. Biol., Dec. 19, 1885, p. 742.

⁶L. d. Bancels (*loc. cit.*).

⁷Plutti. C. R. Acad. d. Sc., 103, p. 134.

⁸Die Organische Geschmackstoffe (Organic Flavors).

⁹Gen. Bibliog. of Taste: 1. Marchand, *Taste*. Paris, Doin, 1903; 2. Zwaademaker, *Taste*. *Physiol. Results*, 2, II, p. 699, 1903; 3. Nagel. *The Sense of Taste*. Nagel's Handbk. of Human Phys., III (2), p. 261, 1905; 4. Vaschide. *Taste* (*Dict. of Physiol.* by Ch. Richet), VII, p. 570, 1907; 5. L. d. Bancels. *Taste and Smell*, Paris, 1912, Hermann.

¹⁰Herlitzka. *Arch. di Fisiologia*, 5, 217 and 17, 557.

¹¹Hoerber and Klesov. *Zts. f. Physik. Chemie*, 27, 601.

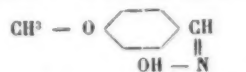
bitter with the exception of the copper ion, which, sweet at first, leaves a bitter after-taste. The second group contains both sweet metals and bitter metals. In the other groups the sweet taste is everywhere found with a few exceptions.

The numerous and well co-ordinated ideas which we possess concerning the arrangement of the atoms in the molecules of carbon compounds enable us to comprehend the great interest attaching to a systematic study of the taste of organic substances. To undertake such a piece of work, and especially to classify the documents assembled by G. Cohn¹² and to state clearly the few laws which it seems possible to deduce from the laborious compilations made by this author, we have thought it wise to follow a plan analogous to that adopted by the physico-chemists in their researches concerning the physical and chemical properties of substances. We, therefore, accept the views of Nernst¹³ to the effect that it is from the molecular architecture of bodies that all their properties are derived. This molecular structure itself depends, first, upon the chemical composition of bodies, second upon their constitution, i. e., the manner in which the atoms are mutually attached and third the stereo-chemical configuration; but these three factors are unequal in importance. Thus it appears impossible to find laws establishing in general the relations between chemical composition and taste.

The complexity of the organic molecule is so great that the presence of one or more atoms introduced into a compound is not sufficient to impart to it a new and definitely specific character. It is only in cases in which the presence of a new element changes not only the percentage composition but gives rise to a group that we are able to observe any influence upon the taste.

Let us take thiophene as an example; the replacement of the C² H² group in benzene by sulphur, thus obtaining C⁴ H⁴ S, causes so little change of properties that the methods of preparing thiophene are almost identical with those used for making benzene, and there is the same similarity in the derivatives of the two substances;¹⁴ the analogy is equally complete in the sense of taste, for the introduction of sulphur into the nucleus of benzene does not alter the flavor. But the same thing is not true of chlorine, which when united with hydrocarbon causes a profound change in the taste of that body because it modifies the constitution of the substance as well as its composition.

The influence of stereo-isomerism (i. e., isomerism of position) upon flavor has given rise to some interesting observations. We have noted above the case of the two asparagines, one of which, dextro-asparagine, is extremely sweet, while the other is insipid. The leucines may also be cited, as well as the phenylamines; the dextro varieties of each being sweet, while their levo isomers are bitter. In the class of the oximes it has been observed that the anti-anisol-oxime is very sweet



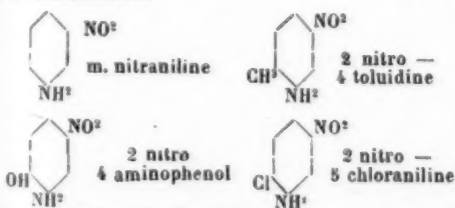
while the syn-anisol oxime has no such flavor. Even a



reader quite untrained in organic chemistry can see at a glance in the accompanying diagrams that the former differs from the latter only in the position of the hydroxyl (O H) group.

Of the three factors involved in the architecture of the molecule the chemical constitution is the one which enables us to analyze the phenomenon of flavor or "sapidity" with most precision; it is this factor which has found a more or less perfect expression in the structural formulae such as those shown above.

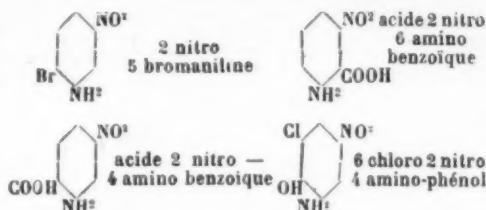
Let us first examine certain general truths. As is the case in all chemical and physical properties a simple analogy of constitution implies the existence of identical properties of taste. This is particularly well shown in the case of the derivatives of the chemical known as meta-nitraniline, all of which are sweet as well as meta-nitraniline itself.



¹²G. Cohn (loc. cit.).

¹³Nernst, *Treatise on Gen. Chem.* I, p. 346.

¹⁴Vanthoff, *Lessons in Phys. Chem.* III, p. 147.



The introduction of the different groups which form these derivatives causes delicate variations or "shadings" in the sweet taste and produces a slight bitterness only in the last ones.

In a series of homologous compounds we find the same flavors, and in general these undergo a regular modification as we pass through the series from one end to the other. However, a few exceptions to this law have been observed, as in the case of phenylurea, for example, which is bitter, though the 1-4 tolylurea is sweet.

Stereo-isomerism, i. e., that of position, is the cause of variations in taste which are subject to no regular rule. Among the three nitranilines the *ortho* derivative is not sweet, the *meta* derivative is extremely sweet, and the *para* derivative is insipid. The 1-2 nitrobenzoic acid is very sweet, while its isomer, the 1-3 acid, is barely sweet, and para-nitrobenzoic acid is bitter. Examples such as these might be multiplied without bringing to light the explanation for such changes.

Three classes of organic compounds, the hydrocarbons, the aldehydes, and the ketones, to which should be added the nitroso derivatives, the carbylamines and the organometallic compounds, form a category of substances in which there has been observed no connection between constitution and flavor. The majority of the hydrocarbons are insipid, a fact which is readily explained by their being insoluble in water or in saliva. Four or five appear to be sweet; this property though rare is, however, found more frequently than is color in this class of substances. In the aldehyde series scarcely more than three sweet compounds are found;¹⁵ cinnamic aldehyde, in which this property is highly developed, cinnanthol or heptanal, and iso-butyl formaldehyde.

Among the open chain ketones only the hexa-chloroacetone is sweet; all the others are bitter.

In the series of ketones in which the group C O (carboxyl) forms an integral part of a nucleus we find two sweet compounds, the tetrahydride of isoquinone or dlketo-hexa-methylene and leuconic acid.

In the following portion of this article we shall try to set forth according to the rules of organic chemistry the analogies which can be observed between the flavors of compounds of carbon and their constitution. . . .

I. FLAVOR IN THE HALOGEN DERIVATIVES.

It has been observed in general that an increasingly great condensation of carbon atoms in the molecule of halogen derivatives diminishes the sweet taste which is nearly always present in the lower members of the series. This taste is strengthened in proportion as the number of chlorine atoms contained in the compound increases.

A. Halogen Derivatives of Hydrocarbons.—The sweet taste is the one most frequent. It tends to disappear in proportion as the molecular weight increases.

Among the di-halogen compounds the sweet taste is even more marked in the pentane and hexane derivatives. Chloroform, which is a tri-halogen derivative, is 40 times as sweet as sugar. In the series of poly-halogen substances scarcely any but the poly-chlorated compounds possess the sweet taste.

B. Halogen Derivatives of the Alcohols.—The substitution of chlorine for a hydroxyl group (O H) in the formula of a glycol or other poly-atomic alcohol does not modify the original taste, which is generally sweet. Bromine on the contrary destroys this property, and so does iodine, with even more energy. It should be noted that a halogen derivative upon the alcoholic root of an ether salt of an organic acid is sweet, whereas a similar substitution made in the acid remainder does not alter the bitter taste common to these ethers.

II. FLAVOR IN THE NITRO DERIVATIVES.

The observations which have been made with regard to taste in the nitrated derivatives principally concern those of the aromatic series. The compounds which contain three or more nitro groups (N O²) are bitter. Those which contain only two such groups are also bitter, with a few exceptions which belong to the series of di-nitrated derivatives of simple fatty hydro-

¹⁵The aldehydes irritate the tactile organs of the tongue intensely.

carbons or to complex aromatic molecules in which the nitro group is attached to a lateral chain. Generally speaking the nitro group causes a bitter taste to appear, except, however, in the case of a mono-nitration.

A. Mono-nitrated Derivatives.—These are frequently sweet. This is true, for example, of nitrobenzene and of nitro-thiophene. In the class of the amines only the meta-nitraniline group is sweet. The sweet taste seems to be produced specifically by the group whose formula is 1-3 NO² NH². The simplest mono-nitrated phenols are sweet. If a halogen be added to the molecule the substance acquires a sub-bitter taste which is increased to an openly bitter taste as the halogens accumulate. This is very marked in the case of bromine, and even more so in that of iodine. The sweet taste is the general rule in the nitro phenolic ether oxides; the ortho-nitrophenol is extremely sweet. In the group of the mono-nitrated acids the bitter taste predominates. Only the 1-2 nitro-benzoic acid and further along the 2 nitro-3 oxy-benzoic acid and the 2 nitro-meta-coumaric acid are sweet.

B. Di- and Tri-nitro Derivatives.—All the aromatic di-nitro derivatives are bitter except the ortho-nitro-diazo-benzene acid and the soda salt of the ortho-nitro-phenyl-nitro-ethanol acid which are two ortho combinations with a nitro group in the chain.¹⁶

[TO BE CONTINUED.]

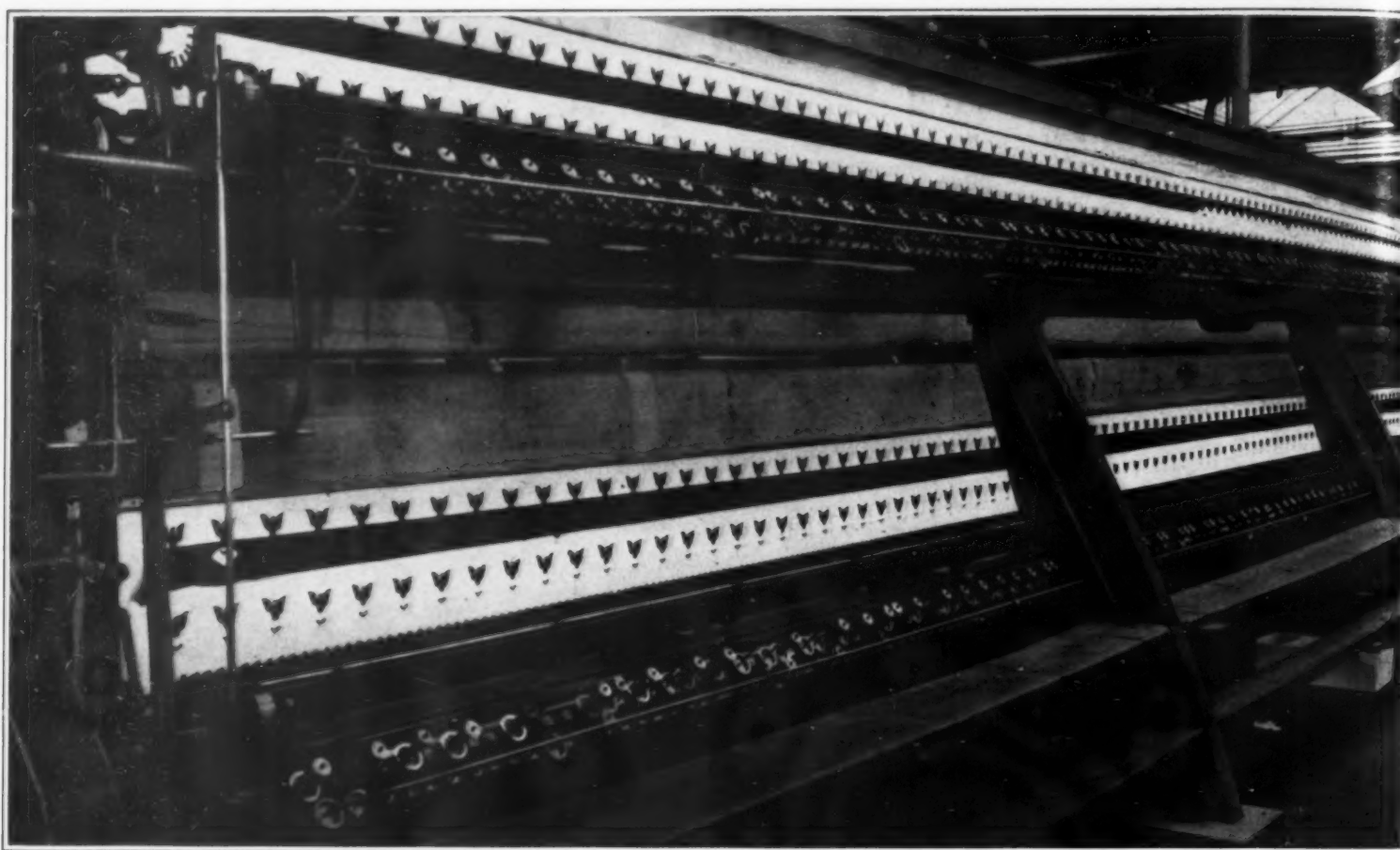
The Skoda Works—Austria's Great Munitions Factory

A serious handicap on any future development of Austria's armaments has been imposed by the secession of Bohemia, in which State is situated the famous Skoda works at Pilsen. For several years past the whole of the ordnance for the Austro-Hungarian land and sea services has been manufactured at Pilsen. In the opinion of the best judges, Skoda artillery, particularly the naval models, was superior to the products of Krupp. The naval guns were remarkable for their high ballistic qualities and the great weight of the projectiles in proportion to calibre. The 12 in. 45-calibre piece, though weighing but 52 tons, fired a projectile of nearly 1,000 lb. with an initial velocity of 2,625 foot-seconds, and was credited with the power of penetrating 19.6 in. of Krupp cemented steel at 5,000 yards. A still more formidable model, of 14 in. calibre, was in view for the new battleships. Its shell of 1,656 lb. had an initial velocity of 2,625 foot-seconds, this being apparently a standard velocity for the 14 in., 12 in., 9.4 in., and 7.6 in. models. The Skoda Works, which were founded on a modest scale in 1859, owed their steady growth to the advantages they enjoyed in the form of cheap coal, pure iron, and excellent railway communications. In 1914 they employed 8,000 men, covered an area of 360 acres, and owned besides coal mines an artillery proving ground. The consumption of coal was 200,000 tons per annum, and the annual output of steel amounted to 30,000 tons. The equipment included six Siemens Martin furnaces, both basic and acid, with an aggregate capacity of 180 tons; and a large Harmet fluid compressed steel plant, in which gun forgings of 50 tons and upwards were made. The ordnance factory was on a very large scale, with plant adapted to the production of every kind of ordnance, from 16 in. down to machine guns. One of its achievements was the supplying of the complete armament of two battleships and three cruisers in thirty months. Another order, for 1,200 field-gun carriages, was completed in fifteen months. There were extensive facilities for the manufacture of all descriptions of ammunition, and a special ammunition laboratory adjacent to the proving ground at Bolowitz, near Pilsen. It appears that the Bohemian authorities have now assumed control over the Skoda concern and its various ramifications, so that this immensely important establishment has ceased to be an Austrian military asset. No doubt the Hungarian Government has taken a similar step in regard to the small gun factory at Roab.—*The Engineer.*

Lead Alloys

It is known that an addition of a small quantity of sodium or magnesium to lead hardens the metal considerably. If tin be added to either of these alloys its brittleness is somewhat diminished, and its resistance to chemical action accordingly increased. According to *Mettall and Erz* an alloy of soft lead and magnesium, which in moist air is slightly attacked on the surface, is proof against such action when tin is added. The tin is equally effective in an alloy of lead and sodium. The hardness of these alloys may be increased by an addition of copper. The proportion of tin, as of copper, must not exceed 5 per cent. The proportion of sodium or magnesium should not be greater than 4 per cent.

¹⁶A. Wahl and Bouvenut, *B. S. C.*, vol. 29, p. 527, 1903.



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A remarkable machine that embroiders 180 insignia at once

Embroidery by Wholesale

How the Chevrons of Our Army and Navy Are Made

EMBROIDERY is supposed to be one of the earliest domestic arts, for it is argued that it must have been employed for decorative purposes very soon after sewing was invented. This would place it long before the art of weaving was discovered, and back in the days when the skins of animals were the only material for clothing that existed. The earliest known specimens of embroidery, however, are some fragments discovered in Egypt, and the earliest of these is supposed to have been made about the 15th century, B. C. Naturally materials of this kind disappear very rapidly, and it is only in a very dry climate like Egypt, with its sandy soil, that fabrics suitable for embroidery could survive.

All countries and all ages have employed this art extensively, and many beautiful specimens of the embroidery of days gone by are to be found in our museums; but it is not alone in purely decorative effects that embroidery is used, for it is widely employed for practical purposes, as we have seen during the last two years in the many insignia on the sleeves of our army and navy men.

Every man holding rank above an ordinary soldier bears some token of his office on the sleeve of his coat, on his collar or cap, and often in all three locations; while in the navy a host of men holding no official rating wear insignia indicating the particular department or service to which he is attached. These specially distinguished men are numbered in many thousands, and if hand work had to be depended upon for making the immense number of insignia required, undoubtedly some other system, or material would have been necessary. Long ago, however, the art was commercialized, so to speak, and cunning machinery was devised that would imitate the work of nimble fingers, and embroidering machines have become comparatively common.

In general principles the embroidering machine resembles the sewing machine, at first with only a single needle arranged to use special kinds of threads, and to form a particular kind of stitch appropriate to the work, and in this machine the material to be embroidered is guided by hand to form the design. The advantage of this machine is that it forms every stitch with great accuracy and speed, and considerable numbers of these single machines are in use for miscellaneous purposes. But where a single design is to be

reproduced by thousands even this is too slow and too costly; so ingenious mechanics have expanded the machine to correspond to the demand, with the results seen in the accompanying illustrations which show 180 chevrons of a chief yeoman of the navy in the making at one time; 90 in each bank of the machine, which handles material about twelve yards long.

The mechanism that makes each of these chevrons corresponds to a single needle embroidering machine, and 180 of them are combined to operate simultaneously, and the machine is also so constructed that instead



Cutting up the finished work

of shifting by hand the fabric on which the embroidery is being placed, this operation is automatically performed by the machine in synchronism with the host of individual needles. The machine works only one color at a time.

When large numbers of reproductions of small, similar designs are to be made a perforated pattern card, similar to those used in jacquard looms, automatically controls the machine, and all the attendance that it requires is to join up broken threads and rethread the

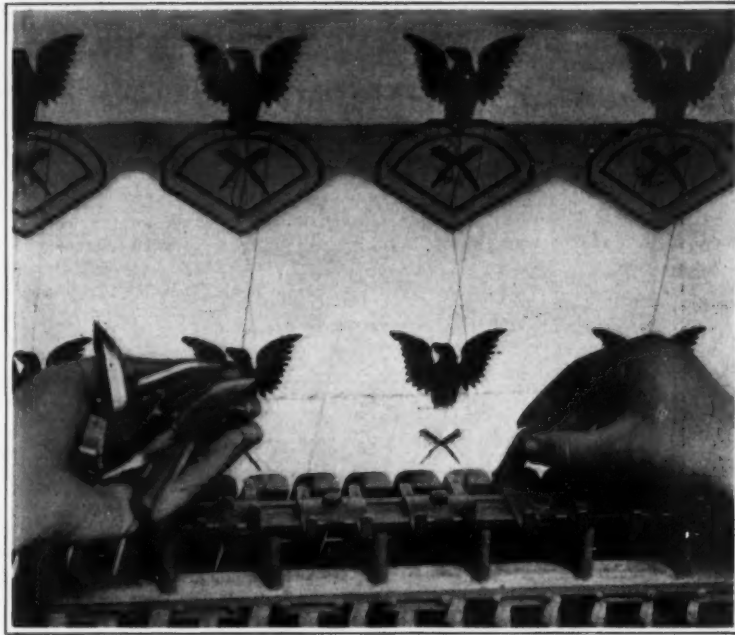
needles, and put in filled shuttles; but some of these large embroidering machines are provided with a pantograph attachment, as shown in the illustration on the first page. In this case the operator follows a drawn design with the pointer of the pantograph, and the machine reproduces the pattern on a reduced scale, and of a size that corresponds with the adjustment of the pantograph.

Diffraction Phenomena of Cultures of Micro-Organisms

DR. A. PIJPER has described certain diffraction phenomena observed with cultures of micro-organisms by means of which the size of the organisms may be ascertained without direct measurement (*Med. Journal of S. Africa*, vol. xiv., 1918, p. 211). It was noticed that certain colonies of a bacterial plate culture viewed with ordinary daylight were colorless, but when the plate was held in the beam of an electric arc at a certain distance from, and at a certain angle to, the source of light, the colonies exhibited a blue color. From theoretical considerations and control experiments the conclusion was arrived at that the coloration was due to a diffraction effect, the thin layer of micro-organisms acting like a grating. For the better observation of the effect the following arrangement was devised: The beam from an electric arc was parallelized by means of a condensing lens and passed through a hole in the proximal side of a closed box. In the box the bacterial plate culture was suspended, the glass of the dish being painted over with black paint except at one spot placed opposite the beam. Immediately opposite the transparent spot a second lens collected the rays, bringing them to a focus on a transparent screen forming the distal side of the box. On viewing the screen the spot in the axis of the beam is colorless, but around this a series of colored rings spreads over the screen. Knowing the focal length of the collecting lens, and measuring the distance of any colored ring from the axis, the size of the slits can be calculated, and, for spherical micro-organisms, the size of the slits is found to be just equal to the diameter of the organisms. This was verified by observations on various micro-organisms, the size found by the diffraction method and by microscopic measurement being practically identical.—*Nature*.



The front of the machine. Threading the needles



At the back of the machine. Putting in filled shuttles

A Museum as a Laboratory*

An Institution of Practical Value to Designers and Manufacturers

A DEMONSTRATION of the practical or trade value of an art museum, a proof of the educational use made of museum objects for the advantage and improvement of current design in many branches of industrial art, is seen at the Metropolitan Museum (New York) in its exhibition of objects and designs which were made for the commercial market but which, in greater or less degree, owe their conception or method of execution to the study of museum originals or other resources in allied departments. An effort has been made to gather a goodly number of examples in varied types of materials, form, color, textures, and technique generally, in many widely separated lines of production, yet all destined for the open market and all showing that museum study has been found worth while in terms of the selling value of the product which results. The most amazing variety of intention as well as of product has been the outcome of the endeavor of the Museum to "make the galleries work." Of reproduction or copying but few indications are seen, while the inspirational use of the finest pieces in traditional styles offers every assurance that American design is rapidly gaining in strength and certainty of contact with the realities of art, as expressed not only in perfect execution but also in breadth and self-possession, qualities without which pure business instincts can never achieve lasting success in the industrial arts manufacturing field.

Manufacturers and designers have found it to their advantage to use the Museum, and this means that they have found it to their business advantage. No greater test of the value of art as related to progress could be offered. Design has been able to demonstrate its own salability, which indicates a by no means insignificant forward step in our valuable art producing trades, trades which represent an annual expenditure of no less than \$500,000,000 for home furnishings alone. The pieces seen in the exhibition of work by manufacturers and designers prove that these manufacturers at least have appreciated that taste is an asset in trade as in life generally. And this, said in business language, means that design sells. Industrial art products since the beginning of time have commanded higher prices only in proportion as a higher degree of attractiveness was superadded to absolute mechanical perfection and suitability for a given purpose. The exhibition which opened in Galleries JS and 9 on January 13 contains several hundred examples in a score of manufacturing and designing fields, and each piece is an argument for the outstanding need of infusing art into daily life by the direct route of making it an indispensable requirement in all industrial art products from rugs to jewelry, from chairs to chinaware.

The questions may be asked: how do manufacturers and designers use the Museum? and what methods does the Museum use to facilitate the use of its materials?

The possible uses of the collections and the various ways in which the searcher after information may make use of his findings are indicated in the letter of

invitation to prospective exhibitors, an excerpt from which follows:

"Whether your field is metalwork, tiles, plaster, stained glass or costume design, whether you make reproductions of colonial furniture or re-design a silver goblet for commercial use, whether you have worked from Byzantine ivories or Flemish tapestries, in jewelry or architectural terracotta, whether you are designer or manufacturer, decorator or craftsman, if the resources of this Museum have been of avail in working up your product, your work will be needed for this exhibition."

From this it will appear that the use of an object of art from an inspirational viewpoint is very much like the use of a book for study. The same volume may offer untold riches to one student and remain cold and blank to another. An Italian gesso-covered and painted picture frame may seem a long cry from the modern market, yet it has been studied by a New York manufacturer of tapestries. An Athenian vessel twenty centuries old has been passed by thousands of visitors until a designer of commercial containers saw in this as in nothing else that had come to her notice a possibility for a modern jar to hold cosmetics. A millefleurs tapestry remained the despair of scores of artists and designers until a manufacturer of rugs determined to take advantage of this design for the improvement of American rugs. A designer of dress fabrics saw possibilities in the armor collection. A china painter studied Russian laces. Embroidered crests assisted in the design of American sport skirts. Florentine glass bottles offered suggestions for printed vials. Ecclesiastical vestments were found full of suggestion for wall papers. The color for painted chairs was found in Chinese pottery. A paper soap wrapper design saw its beginnings in snuff boxes.

These are a few of the actual cases of recent weeks, all showing that in tracing fundamentals of design the manufacturer or his designer seeks his inspiration wherever it may be found and the differences of material, style, artist, period, race, or purpose are not considered barriers. Thus they have at their command the entire field of industrial art design of all ages, and their only limitation is that they shall properly express in terms of their own materials the design and purposes of the pieces which they themselves are producing.

And all of these uses of the collections are duplicated in the use of the Library and of the photograph collection and again in the use made of purchased photographs. The Museum sells annually no less than sixty-five thousand photographic prints, all of which serve students' or designers' purposes.

Then there is the direct line of inspiration which remains a constant source of assured refreshment, having stood the test of age-long examination; that is, the use of furniture collections by furniture designers and manufacturers, or of the textile collections by textile manufacturers.

To meet these requirements on the part of the modern manufacturing and designing world, the Metropolitan Museum maintains a large and efficient force of assistants and an extensive system of study rooms, lantern slide and photograph collections, lending collections, and other physical means of assistance. There

are a number of docents or museum instructors familiar with every detail of the galleries and their contents and there is a specially trained associate whose province it is to assist in bringing together the seeker and his objective, to act as a sort of liaison officer between the Museum and the world of art in trade. This member of the staff is a person qualified to assist manufacturers and designers from the standpoint of their own requirements. He makes it his business to visit shops and workrooms, he is familiar with the processes of manufacture and keeps abreast of the market, so that he shall be able to visualize trade values in museum facilities and thus help manufacturers toward their own objectives. To this extent he becomes a field worker and an advocate of the museum militant.

Scores of manufacturers and designers have taken advantage of this particular type of museum usefulness within the last five months; of these at least thirty had not definitely studied museum values as invested in business values before that time. The exhibition of work by manufacturers and designers, on view from January 13 to February 16, demonstrates some of the results of this type of museum activity, nor are all possible exhibits included, since transportation difficulties, the demand for early deliveries by clients of prospective contributors, not to mention other handicaps, have militated against their inclusion. To the exhibitors here represented the Metropolitan Museum desires to make grateful acknowledgment, in view of their spirit of earnest co-operation and their recognition of taste as an asset in business.—R. F. B.

Determination of the Adhesiveness of Glue

THE solution of the glue is applied to the planed end surfaces of two pieces of red beech wood 185 mm. long, 125 mm. broad, and 50 mm. thick, and these are placed so that the glued surfaces cross at right angles. The glue film is then allowed to dry under definite pressure, and the force required to tear the pieces of wood apart is measured by means of a suitable machine. In a series of determinations made in this way it was found that for glue solutions up to 200% of water (referred to weight of glue dried at 100° C.) the tenacity of the film decreased in proportion to the extent to which the wood was heated prior to glueing, but that in the case of solutions with 300% of water the greater degree of heating had a favorable influence. The tenacity of the glue film does not decrease in direct proportion to the rise in the amount of water. In the case of solutions with 100 to 150% of water the pressure under which the glue film is dried has no appreciable influence on the tenacity of the film, but with higher amounts of water the drying pressure has considerable influence, especially when the wood has been previously heated. The most suitable conditions for testing samples of glue by this method are the use of solutions containing 150% of water, previous heating of the pieces of wood to 40° C. in dry air, and drying of the film under a pressure of not less than 0.84 kilo. per sq. cm. Solutions containing 100 to 150% of water give concordant results by this method, which may also be used for comparison with the results obtained by determining the viscosity at 35° C. of glue solutions with 556% of water.—Note in *J. Soc. of Chem. Ind.* on a paper by M. Rudloff in *Mitt. K. Materialprüf.*

*Bulletin of the Metropolitan Museum of Art, New York.

The Pleistocene Man of Vero, Florida

A Review of the Latest Evidence and Theories

By F. H. Sterns, Ph. D.

SEVERAL months ago, in an article on the fossil human remains found on the east coast of Florida,¹ I endeavored to present to the readers of the SCIENTIFIC AMERICAN SUPPLEMENT the impressions which a controversy then raging, made upon a disinterested spectator. Although the geologists and anthropologists who had studied the locality could agree neither on the facts nor on their interpretation, I tried, nevertheless, to tell a consistent story of the ancient history which those fossil bones revealed.

At that time it seemed that the stronger case had been made by the supporters of the theory that the Vero remains were of Pleistocene age, and that, at last, we had definite proof of the glacial antiquity of man in America. Those holding the opposite viewpoint had abandoned many of their arguments, and most of their contentions had been shown to be fallacious. That man had lived in Florida at a time when it was inhabited by animal species now extinct, appeared to have been proved.

Since then, however, many new articles have been published. Old arguments have been revived in a new and stronger form, and new reasons for scepticism have been raised. Therefore it seems advisable to examine anew the evidence to see if the case for the Vero man is as strong as it was at that time.

The readers of the SCIENTIFIC AMERICAN SUPPLEMENT will no doubt remember that the geological section at Vero consists of three principal formations. The lowest and oldest of these is a marine shell marl, which is part of an extensive series of marine marls which border the Atlantic coast, beginning on the north near St. Augustine, and extending southward to the Everglades of Florida. All the investigators agreed in assigning this marl to Pleistocene times, although most of its fossils belong to recent species.

Bed number 2, resting unconformably on the marine shell marl, consists of distinctly cross-bedded river-wash sand, mixed with partially decayed wood. The invertebrate fossils found in it are of fresh water species and have a pronounced modern aspect. Many of the vertebrate species, however, are extinct species such as we would expect from Pleistocene times.

Separated from bed number 2 by an unconformity is stratum 3, which is an alluvial deposit, consisting chiefly of vegetable material intermixed with sand. It contains numerous fragments of bone belonging in many cases to extinct species, although modern forms are relatively more common than was the case in the preceding bed.

Across these formations runs the channel of a small stream, which has recently been deepened and straightened to form a drainage ditch. In the sides of this "canal" Dr. Sellards of the Florida Geological Survey found traces of man, mingled with the bones of extinct mammals, and with the remains of plants not known to have existed later than Pleistocene times. These traces of man consisted of scattered fragments of human bones, some roughly chipped flint flakes, and a few small pottery fragments. The human bones were even more broken and scattered than were those of the mammals with which they were associated. Their degree of mineralization was as great as that of any of the known Pleistocene forms. The possibility of intrusive burial seemed to be excluded by the presence, above the bones, of distinct stratification. It is true that the age of the deposits in which the bones occurred had been questioned, but on insufficient grounds, as we have already seen. On the basis of these finds, the discovery of Pleistocene man has been announced.

Some slight attempt is still made to consider the geological formations in which the bones were found as of Recent rather than of Pleistocene age. It is argued that in the comparatively mild climate of Florida, species might have survived later than they did in other parts of the United States, and hence might be Recent, although in other parts of the United States they would be deemed Pleistocene. Of course this argument is pure assumption, and unless it is supported by some positive proofs that such a survival actually took place, it is of little or no value. Furthermore, it was more probable that many of the animals, represented in these formations, would have perished more quickly in a genial climate than they would have in a more rigorous one.

In this connection, Dr. Hay has pointed out an incon-

sistency between the position his opponents take now and that which they did in a former controversy in regard to glacial man. At that time it was to their interest to prove certain deposits to be of Pliocene age in order to discredit the idea that man was contemporaneous with them. As Hay says:

"It is not a little amusing to observe that the camels and horses and their fellows, which under the designation of a 'Pliocene fauna' were used at Table Mountain to combat the existence of early man, are now, at the other, far distant, end of the line mustered in as 'mid-Recent' fauna and called into service to continue the same war."

Some have argued that because the culture of man was so high at the time the formations were laid down, they could not possibly be of Pleistocene age. This position, however, has been abandoned, because it was seen that the age of the human remains was the thing in question, and hence they could not be used to determine the age of the deposits.

The most serious geological question has been raised by Hrdlicka, who questioned the right of geology to discuss the question at all. In his own words:

"It is scarcely safe for the geologist or paleontologist to assume that the problem of human antiquity is his problem. . . . In all cases in which the remains of man are concerned, be they cultural or skeletal, there enters a most important factor in the case which does not exist for the geologist and paleontologist, namely the human element."

The supporters of the Vero man have not attempted to answer this theoretical argument on theoretical grounds. Instead they have dug out from the literature statements by their opponents, at a time when the geologists were on the negative side, but the archeologists were not. So they are able to quote:

"Little by little the advocates of paleolithic culture in America have been forced to give up the idea that there is any other reliable test of the age of a culture than that furnished by geology."

Personally I cannot help but be amused at such an effective come-back as this is. Nevertheless I do feel that Hrdlicka's argument has not been completely met. There is a human element which must be considered. Animals die, and natural processes determine whether or not their bones will be covered up, and so survive. With man it is different. His bones are deliberately buried by his fellow-men. At the same time, the works of his hand are introduced into deposits which are vastly older than himself. The possibility of intrusion is one which must always be watched in the case of man.

As Hrdlicka says:

"Like inorganic materials, the remains of plants and animals are passive objects, affected only by the action of living plants and animals and that of the elements. In the main they find their resting places accidentally, and, unless they sink into the soil or are displaced by some agency subsequent to their deposition, they constitute safe evidence of contemporaneity with other similar objects and with the geologic components of the same horizon. Not so, however, with the remains of man. Accidentally or intentionally he introduces cultural objects into the ground, and from the earliest known times has buried his dead at varying depths, thus introducing his remains into deposits and among other remains with which otherwise they have no relation."

This seems to be putting the argument a little too strongly, as a slight modification of it will show. Thus, one could say that human remains are passive objects, affected only by the action of living plants and animals (including man) and that of the elements. In the main they find their resting places through no choice of their own, and, unless they sink into the soil or are displaced by some agency subsequent to their deposition, they constitute safe evidence of a geologic age at least as old as the lowest undisturbed stratum above them. Not so, however, with the remains of beavers. Accidentally or intentionally, they introduce "cultural" objects into the ground, and from the earliest known times they have died in burrows of varying depths, thus introducing their remains into deposits and among other remains with which otherwise they have no relation.

The answer, then, to the criticism of geologists for meddling with a problem they do not understand is that geologists are dealing with that sort of a problem all the time. The possibility of intrusion or sec-

ondary inclusion is always present, and the human form of it is one of the easiest cases to discover. There is no more reason why an anthropologist should be required in the determination of the stratigraphic relations in the case of human remains than that he should replace the geologist in the case of fossil rodents.

The question to be answered is not whether there might have been an intrusive burial, but whether such a burial actually took place. As we have already seen this does not appear to have been the case at Vero, as definite stratification occurs above the human remains, and these remains are widely scattered. Attempts to answer both of these objections have been made. Against the first, a brand new kind of dynamic geology has been created. According to Hrdlicka, stratification may develop by "rearrangement" due to seepage and settling which in time "would not be distinguished from the surrounding undisturbed parts." Needless to say if such "adventitious stratification" can arise after a deposit has been laid down, then geology as a science is impossible. So contrary is this condition to all we are familiar with in Nature, that we can believe it possible only if we have a concrete case where it has actually occurred.

Hrdlicka endeavors to give us a concrete case of its occurrence. He publishes a photograph showing such "adventitious stratification" in the dumps on the southern bank of the Vero canal. This is hardly an example, however. Dredging operations, in many ways, resemble the natural condition for the formation of laminations, and the stratification is formed not subsequent to the deposition, but during it. Furthermore even in this case, Hrdlicka is able to distinguish the original stratification from that of the dump.

As to the scattered positions of the bones, it has been argued that the "dissociation and fragmentation occurred later owing to movements, stresses, root action, and other agencies operating on or within the deposits inclosing the body." The supporters of the Vero man point out, however, that with the Vero remains these movements would have had to occur in directions at right angles to each other, and that some of the bones would have had to migrate twenty feet through the soil. Then they add that perhaps we get a clue here to the reason why civilized people nail up their dead in good strong boxes.

The next argument which has been brought forward is that both the bones and the artifacts are similar to those belonging to modern Indians. Hrdlicka argues that we have a right to expect geologically ancient man to present certain physical characteristics [which characteristics, however, he does not name] which differ from those to be found among any modern types. He finds that the Vero man fails to show these characteristics. However it is interesting to note that he found that they were not like the modern Florida Indians. He fails to give an explanation of this discrepancy although he suggests that the skeleton might belong to a mixed white-Indian or some exceptional superior individual of a non-Florida tribe.

The pottery and the artifacts likewise have given rise to the same argument. They are neolithic in appearance, and they resemble closely those of the Indians living in the same vicinity a few centuries ago. Therefore the people that made them were too far advanced to have been living in Pleistocene times.

The difficulty with both of these arguments is that we do not know the actual conditions physically and culturally of Pleistocene man in America, and until we have a better standard by which to judge than our own *a priori* theory of what Pleistocene man looked like, we have no right to decide that any given specimen is non-Pleistocene by its type.

It is certain that we cannot judge Pleistocene man in America by the conditions found in Europe. Nobody claims that man originated in Europe. He may have migrated there earlier than he did to America, but this must be settled by the evidence from human fossils. His culture development may have been the same in America as it was in Europe, or it may have been wholly different. The point is that we cannot accept European standards for American facts, until we know they apply.

In regard to the pottery, it is pointed out that pottery has been found in America in the Pleistocene in three different localities—Charleston, Vero, and Nampa. "Did an Indian go out furtively into that swamp at Charleston, dig down three feet in the muck, and hide

¹F. H. Sterns: The Pleistocene man of Vero, Florida; SCIENTIFIC AMERICAN SUPPLEMENT, No. 2214, New York, June 8, 1918, p. 354-355.

away from his fellows, alongside of the mastodon tusk and horse teeth, that potsherd?"

Furthermore one writer has recently shown that the pottery did not have as modern an appearance as was first supposed. The Vero pottery is plain, while the late mound pottery is decorated. Its paste is not of the "chalky" sort which is found in the shell mounds, but of a "gritty" sort which never occurs there. On the whole it is much cruder than the late mound pottery.

This discovery of new characteristics in the pottery may later be matched by like discoveries for the bones. One may well recall the case of *Pithecanthropus erectus*, where the thigh bone on close examination was proved to be much more primitive than it was believed to be at first. In this connection, Hrdlicka's uncertainty, as to whether the bones belonged to a Florida Indian or even to any Indian, is instructive.

The last argument of importance is that if man had reached America in very early times and spread as far as Florida, he must have left numerous remains

over the whole continent, some of which would have been discovered by now. It is said, however, that no such finds have been made. Hay points out that numerous cases of Pleistocene man have been found. Holmes denies the validity of any of these finds, and characterizes Hay's map as "Danger signals for the Study of human history." Many of these former finds have been discredited by this same argument of "isolated case." If this argument is allowed to stand, no science of any kind is possible. For no matter how many examples of a thing you have, if you examine each example separately, on such a basis you can pronounce it an "isolated case" and so reject it. Therefore there could be no such thing as cumulative evidence.

Thus after the new arguments have been brought forward by the opposition, and the replies are all in, the case for Vero man appears to be stronger than it was six months ago. The importance of the problem is so great that we still hesitate in our convictions al-

though the supporters of Pleistocene man in America appear nearer a definite triumph.

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Titanium and Rutile

TITANIUM is a solid element known by the symbol Ti, and is one of the rarer and less known metals. This element was discovered by Berzelius nearly a century ago, in 1825; its atomic weight is 48.1; its specific heat is 0.112 and specific gravity 5.17; for comparison the specific gravities of iron and tungsten are given, 7.85 for the former and 18.77 for the latter. The melting point is 1,795 deg. C., approximately similar to that of iron.

The metal titanium is mainly derived from deposits of a material known as rutil, which is a reddish-brown, or nearly black mineral composed of titanium dioxide. It occurs extensively among rocks, but is only very occasionally found in large quantities. It may not be generally known and is certainly noteworthy, that titanium occurs in larger quantities in the earth's crust than copper, lead, zinc, or any of the common metals except iron, but it is nevertheless one of the rare metals, due to the absence of concentrated deposits. Moreover, the metal can only be separated from the ore with extreme difficulty; that is an obstacle to its more extensive use, which time, research and study will no doubt overcome in the early future. Water-power and the electric furnace are essential for the production of titanium, as the smelting of its alloys by other than the electric furnace process is commercially impracticable. As stated in detail below, the largest sources of the world's output of titanium occur in the United States and Norway, both countries in which ample water power is available. Titanium in the metallic form does not occur in nature. In addition to rutil a mineral known as ilmenite, a titaniferous iron ore carrying varying quantities of titanic oxide, known to occur in many localities, is a source of titanium.

The following additional details of rutil may be noted: it is found massive in igneous, sedimentary and metamorphic rocks; gives a pale brown streak; its hardness is about 6.5 and its specific gravity 4.2 to 4.3, somewhat less than that of titanium. The mineral frequently contains as much as 98 per cent. to 99 per cent. of titanic oxide and from 1 per cent. to 2 per cent. of ferric oxide. Ilmenite, or titaniferous iron ore, is an iron-black mineral occurring massive, or in the form of thin plates, or grains; its hardness is 5 to 6; specific gravity 4.5 to 5, and lustre submetallic. The fracture is conchoidal and its streak brownish-red to black. The composition of ilmenite is represented by the formula FeO, TiO_2 , corresponding to 47.3 per cent. of ferrous oxide, and 52.7 per cent. of titanic oxide. Considerable percentages of titanium also occur in other minerals, including titanite, or sphene, a calcium titanium silicate; in brookite and in octahedrite, crystalline forms of titanic oxide.

There are large deposits of rutil in Virginia, near Roseland in Nelson County, which are worked in open cuts; smaller deposits have been discovered in numerous localities on the Atlantic side of the United States. The rutil-bearing rock of Roseland has the appearance of a syenite, the rutil forming about 5 per cent. of the rock worked. The output of this great rutil quarry has been affected by the war as shown below. The world's main supply comes from Virginia.

1912 Output: 275 tons of concentrate rutil carrying 80 per cent. to 85 per cent. of titanic oxide; also 100 tons of ilmenite containing 94 per cent. or more of titanic oxide.

1913 Output: 305 tons of rutil and 250 tons of ilmenite; the latter being separated from the rutil concentrate by a magnetic separator.

1914 Output: Was only 94 tons, carrying 95 per cent. of titanium dioxide and 89 tons of ilmenite, carrying 55 per cent. of titanium dioxide.

1915 Output: The 1915 output of rutil (titanium dioxide) increased to 250 tons, but was still below that of recent peace years; a considerable quantity of ilmenite (titanium iron oxide) was also obtained. In addition to the Roseland quarry mentioned above, from which the main output is obtained, there are in the same district several dikes containing ilmenite, a mineral containing varying amounts of iron and titanic oxides. These deposits have value as a source of titanium for purposes where the presence of small quantities of phosphorus is not objectionable. Some of these deposits are on a large scale, one dike is 30 ft. in width and approximately half-a-mile in length.

Europe.—In Europe there are large deposits of rutil in the Kragero district, north-east of Kristiansund in Norway. The output of nearly pure rutil, and some lower-grade material, is about a fifth of that of the Virginia quarries.

Australia.—There have been small outputs of rutil in the hundred of Talunga, about six miles north of Blumberg in South Australia. Rutil is also known to occur in Queensland. Deposits have been noted in Western Australia, Tasmania and New Zealand.

Canada.—Large and important deposits of ilmenite occur in many districts of Quebec; a very extensive one is situated in Saint Urbain, near Bale St. Paul. The ore bed is described as being 90 ft. in width, the ore containing both rutil and ilmenite, with 45 per cent. to 50 per cent. of titanium dioxide.

Asia.—In both India and Ceylon ilmenite is the chief constituent of the crude monazite sands of Ceylon and Travancore. The output of monazite in India has been as follows recently:

1915, £33,200.....	1,107 tons.
1916, £37,700.....	1,292 tons.

Africa.—Titanium ores are known to occur in Nyasaland, Nigeria and the Gold Coast.

An important if not the chief use of titanium ore is as a source of titanium-iron alloy, as detailed below. This alloy may be obtained by the following method, aluminium being used as a reducing agent. The titaniferous iron ore is charged into a bath of molten aluminium, kept fused in an electric furnace. The iron is reduced first, and in this the titanium, as it is reduced by the aluminium, dissolves, yielding ferro-titanium. When rutil is used scrap iron is charged into the bath before the mineral. By this process alloys containing from 10 per cent. to 75 per cent. of titanium and only 0.12 per cent. to 0.75 per cent. of carbon can be obtained in quantity. To quote an expert, when the presence of carbon in the alloy is not objectionable, the ore can be mixed with carbon and reduced in the electric furnace; this process gives an alloy containing from 6 per cent. to 8 per cent. of carbon, suitable for treating cast iron. Some ferro-titanium samples may contain minute quantities of phosphorus and sulphur, or only the former.

The beneficial effect of titanium is not that of an alloying element proper, as the titanium acts simply as a purifier. It is a powerful deoxidiser, and removes a portion, if not all, of the nitrides as well, by uniting with those objectionable elements, forming stable compounds, which pass off in the slag; the energy of combination is so great as perceptibly to raise the temperature of the molten metal. Steel and iron by this treatment acquire freedom from blow-holes and other imperfections, also greater strength, elasticity and wearing properties. Moreover, titanium prevents brittleness, hence the carbon content of, say, rails, may be materially increased and should be increased, if the full benefit of the titanium treatment is to be obtained.

So recently as some ten years or so ago titanium compounds were only used to a very limited extent;

it is only since the development of the high temperature electric furnace and the discovery of considerable and workable deposits of rutil, that the manufacture of titanium products on a commercial scale has become possible. The pure metallic titanium has only been very moderately used in the arts and industries on account of its high melting point and great affinity for oxygen; but when it is alloyed with other metals and in various chemical compounds many uses have been suggested and found for it. Titanium forms alloys with several of the metals, the most important being, of course, with iron, resulting in ferro-titanium; it is quite a decade ago that titanium was added to steel in the form of ferro-titanium, containing preferably from 10 per cent. to 20 per cent. of titanium, a quantity sufficient to form about 0.1 per cent. of the steel. An essential quality of titanium is its power to give slags, mentioned above, sufficient fluidity to separate completely from the metal. The presence of titanium oxide lowers the melting point of the slags occluded in steel and iron, imparting sufficient fluidity to account for their elimination.

Titanium has been used in the manufacture of mordants and dyes. Titanium oxalate and titanium ammonium oxalate, when used with a tannin compound, give a golden yellow color of great durability, and by the addition of other substances any desired shade may be obtained. Titanous chloride has been proposed as a mordant and titanous sulphate has been suggested as a stripper and mordant; they yield bright fast colors intermediate in shade between those produced by chromium and aluminium. The double pyrosulphates of titanium and the alkali metals have been suggested as applicable for textiles, as no injury to texture or materials results from their use. The titanium oxalates and the double tartrates and lactates of titanium and an alkali metal have also been applied to leather dyeing. Titanium ferrocyanide has been proposed as a substitute for the poisonous Schweinfurth green and other arsenical pigments. In the porcelain industry rutil has been used alone to impart a beautifully soft yellow color under the glaze, while with other substances secondary colors can be obtained; very few colors are available for underglaze painting, as they must be able to resist the high temperature of the kiln. Metallic titanium and oxygen combine with great energy, producing an instantaneous dazzling light; titanium also combines readily with the nitrogen of the atmosphere forming nitrides, which yield ammonia when heated in the presence of hydrogen. Crystals of rutil have occasionally been found sufficiently clear to be used as gems.

The effect of titanium on the magnetic properties of iron have been carefully studied during recent years. Iron is rendered magnetically softer by annealing, or by the addition of foreign material so as to reduce hysteresis; silicon and aluminium have been found efficacious. Included in the effects of titanium are: a decrease of hysteresis and an increase in permeability obtained when less than 1 per cent. of titanium is used; but an increase in hysteresis results when a larger percentage is added. Prolonged annealing at 700 deg. C. fails to soften the material. It is all important to use absolutely pure metal, as commercial titanium alloys cause deterioration in quality. Comparing titanium steels with standard silicon steels, some authorities prefer the latter.—*Engineering*.

Substitutes for Lubricating Oil

EXPERIMENTS have shown that hydro-naphthalenes, especially tetra-hydro-naphthalene, deka-hydro-naphthalene, and their intermediates may be used as substitutes for common lubricating oil. With fats or fat-oils they may be used to lubricate machinery.—*Chem. Zeit.*

The Camelidæ of the New World*

South American Relatives of the Camel

By Edward Albes, Pan-American Union Staff

JUST where the writer, when quite a small boy, received the impression that black alpaca coats and dresses were made from the woven hair of a species of goat is a mystery to him. However he may have obtained the misinformation, it certainly made quite an impression, for to this day when something is said of the animal known as the alpaca the image of a goat appears before his mind's eye, and it is with some effort that he pulls himself together with the mental whisper, "Not goat, but a camel."

The trouble is, the animal does not look like a camel in any feature but its neck, and there have been quite a number of others, many of them more familiar with the alpaca and llama than is the writer, who have had



Llamas, as conceived by an artist of 1688. This quaint picture is from an old volume containing Sir Paul Rycaut's English version of the Royal Commentaries of Peru, by the Inca Garcilasso de la Vega.

more or less difficulty in assigning to these animals their proper zoological status. For instance, one of the best accounts of the four species of the American genus of the family *Camelidæ* that has been published in English is embodied in a little work published in London in the year 1811 under the title "An Historical and Descriptive Account of the Peruvian Sheep called Carneros de la Tierra, by William Walton." Thus Walton called them sheep, notwithstanding the fact that he knew they were related to the camels, as will appear in the following excerpt from his introduction:

"The distinct kind of Peruvian sheep called by the Spaniards Carneros de la Tierra, or country sheep, are four, viz., the Llama and Alpaca, domestic animals and beasts of burden, and the Huanaco and Vicuna, which are wild, and never yet tamed but in some solitary instances. Though they all appear to be intermediate species between the camel and the sheep, and as it were, a delicate mixture and blending with the stag, yet we consider them respectively as perfectly distinct in their genus, as is the ass from the horse, notwithstanding that alliances are made between them, so that, though their generic denomination is the same, the races are different, and differ in their perceptible characters. Without being descended from the camel, they have some marks of exterior resemblance, and are possessed of some of his properties, without having any of his deformities."

Again, to show the confusion that once existed among naturalists as to the proper classification of these ani-

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Typical Llama head and neck. The ordinary height of the Llama is from 4 to 4½ feet

mals, we may quote the beginning of Walton's account of the llama:

"The Llama of the Spaniards; the Huanaco-Llama of the Peruvians; the *Oris Peruana* of Hernandez and of Marcgrave; the *Camelus-Glama*, *dorso lævi*, *toph pectorali*, of Linnaeus; the *Camelus pilla brevissimis* and the *Chameas du Perou* of Brisson; the *Allo-Camelus* of Scaliger; the *Oris Indica* of Gesner, is considerably the largest, strongest, and stoutest of all the four species of Peruvian sheep," etc.

Our contemporaneous zoologists, however, have about settled the matter of classification by giving to the South American genus of camels the name *Auchenia*, defined by the Century Dictionary as "a genus of ruminants, of the family *Camelidæ*, representing in the New World the camels of the old, but having no hump. The genus includes four important and well-known quadrupeds indigenous to South America—namely, the llama



The Vicuña, the smallest of the *Auchenia*, rarely over 3 feet high

(*A. lama*), the guanaco (*A. huanaco*), the alpaca (*A. pacos*), and the vicuña (*A. vicuña*).¹

That definition may be somewhat misleading to a reader unfamiliar with certain zoological facts connected with the discovery of fossil remains of various species of the genus *Camelus* in North America. In this connection it may be stated that perhaps the earliest known form which can definitely be included in the camel series is *Protylopus*, of the Upper Eocene geological age. This animal was no larger than a common hare, and while the skeletal remains that were discovered are very imperfect, distinctive cameloid features were found in the teeth, jaws, bones of the legs, and in the feet. In the Miocene a somewhat higher



Ancient Incaic ornaments representing the Alpaca and Llama. Archaeological objects found on the Island of Titicaca, in the lake of the same name, in silver, probably wrought centuries before the Spanish conquest.

form of development and considerably larger in size was found, and given the name *Pocbrotherium*, while the *Procamelus*, really entitled to be regarded as a camel, and which attained to the size of a small llama, does not appear until the Upper Miocene. These very early forms have been found in North America, so that the New World was perhaps the earliest home of the ancestor of the humped genus *Camelus* as well as of the straight-backed genus *Auchenia*.

It is not, however, with the genus *Camelus* that this sketch is to deal. It is with the Carneros de la Tierra, or South American genus with its four species that we have to do. Of these, as has heretofore been stated, two species, the llama and alpaca, are tame; the other two, the guanaco and the vicuña, are wild—in fact, rather excessively wild. The two former were do-

¹While the name *Auchenia*, bestowed on the genus by the German naturalist Illiger (1775-1813) and which seems to have been subsequently adopted by Cuvier, has been accepted by many naturalists, most English authorities cling to the name *Lama*, given it by Cuvier originally. According to the 1915 "Catalogue of the Ungulate Mammals in the British Museum (Natural History)," compiled by R. Lydekker, F. R. S., the family *Camelidæ* is divided into two existing genera, viz., *Camelus* and *Lama*. The last named genus is composed of two species, viz., *Lama glama* and *Lama vicuña*, Lydekker grouping the domestic llama and alpaca with the wild guanaco as three varieties of the first named species, while the vicuña is the sole representative of the last named. The fact that the offspring of a cross between the llama and alpaca is sterile seems to be ignored, and it is this fact which leads the writer to the conclusion that the difference between the two is more than merely varietal.



Llamas bearing loads. Each animal will carry about 100 pounds



Llamas are gentle and easily managed, but if overloaded will lie down and refuse to rise

mesticated by the Indigenous races of the Peruvian and Bolivian Andes—how many centuries ago no one knows. To the Peruvians of the earliest times of the Incas, perhaps a thousand years before the discovery of America by Columbus, the llama was as well established a beast of burden as was the camel to the Arabs when Christ was born. No doubt those old builders of the megalithic ruins on the southern shore of Lake Titicaca, where now stands the little village of Tiahuanacu, used the llama to carry their lighter loads and wove their garments from the fur of the alpaca. At any rate, there was no record of a time when the Incas or their antecedents did not have the tamed llama, so that the domestication of the camels of the New World, like that of the camels of the Old, must have first taken place in the days of hoary antiquity.

If there had been any account of the taming of the llama in Inca legends or traditions unquestionably such an important fact would have been mentioned by some of the old Spanish chroniclers, such as Padre Acosta, in whose "Historia Natural y Moral de las Indias" appears an excellent description of the llama as a domesticated beast of burden. In the "Comentarios Reales de los Incas" of the Inca Garcilaso de la Vega is also to be found a good account of the domesticated animals of the Peruvians, including the llama and alpaca. The Inca Garcilaso, who was the son of an Inca princess and one of the Spanish conquistadores, had spent the early years of his life in Peru, knew the language of the Peruvians thoroughly, and was familiar with their traditions and every feature of their lives. He went to Spain in 1560, and some time thereafter published his celebrated "Comentarios," perhaps the most interesting work dealing with the history, customs, forms of government and religion, and Peruvian activities of all kinds, that has ever been penned. The earliest complete English translation of this work was made by Sir Paul Rycaut, published in London in 1688, and from this translation the following quaint account of the llama is taken:

"The tame Cattel (animals) which God hath given to the Indians of Peru, are of two sorts, which, as Blas Valera saith, are of a Disposition as gentle and easie as the Indians are themselves; being so tame, especially those which serve to carry their burthens,

that a Child may be able to govern them. These are of two sorts, some of a bigger kind, and some of a less; in general the Indians give them the name of Llama, and the Shepherd or Pastor of them, Llama Míchee. In



The Guanaco, the wild relative of the Llama. It is seldom over 3½ feet tall

distinguishing them one from the other, they call the greater Huanacullama, because it hath a likeness with that brave and fierce Creature, which is called Huanacu, being of the same shape with it, but different only in the color; the tame Huanacu varies as much in its

colors as the Horses do in Spain, but the wild is of a dark Chestnut color only. This Creature is about the size or bigness of the Hart or Stag in Spain, but resembles a camel most of any other, the hunch upon the back onely excepted, but in proportion is but one third of its bigness; its Neck is long and smooth, the Skin of which being flead, the Indians used to make it gentle and supple, and being dressed after their fashion, served for soles to their Shoes; but because they had not attained to the Skill of Tanning of Leather, they always took off their Shoes when they were to pass wet (places), or Waters, because the moisture spoiled them, and made them like a Gut, or Tripe. The Spaniards made reigms of them for their Horses, after the fashion of those which come from Barbary, as also Girts and Cruppers for their Saddles. This sort of Cattel is useful both to the Indians and Spaniards, for carrying their merchandise from and to what place they please; but commonly they chose such ways where the Countrey is plain and even, as is between Cosco and Potocheli, being about two hundred Leagues; and likewise from many other parts they go and come to and from those Mines, carrying Provisions, Commodities of the Indians, Merchandizes from Spain, such as Wine, Oil, Conserves, and all other things which are consumed in the Countrey, and especially that Herb which is called Cuca. I remember that in my time they had Drovers of that Cattel which carried burthens, sometimes six or eight hundred, or a thousand in a Caravan; and that a drove of five hundred was esteemed as nothing. The burthen which one of these Beasts will carry is about three or four Aroves (an Arove in Spain is about twenty-five pounds weight), and will travel about three leagues a day, which is about nine Miles. They are not to be driven beyond their usual pace, for if they are, they will tire, and lie down, and then all that can be done to them, cannot raise them, though they ease them of their Burthen, and take off their Saddles; for when they come to raise them up, they presently eject all they have in their Maw, or Stomach, into their Mouths, whence they cast it, if possible, into the Faces of those who disturb them; which seems to be the onely Revenge and instrument they are able to exercise, having no Horns like the Stag or Hart. Howsoever, the Spaniards call them



A typical drove of Llamas. It is a ruminant, and chews its cud like the cow



A pair of Alpacas. They have the general characteristics of the Llama, but resemble a sheep

Mutton, or Sheep, though the difference between these and those be as much as we have before mentioned. And that these Creatures, nor any of them, may tire, and hinder the travels of the whole Caravan, or Drove, they have always forty or fifty of them, which go loose, and free of burthen in their company, and so soon as they observe that one begins to tire, they presently ease him of his Burthen, and lay it upon another, for if he once lies down, there is no remedy, though you kill him, to raise him again. The Flesh of this sort of Cattel is the best, and most savory of any in the World, being both tender and wholesome. The Physicians prescribe the Flesh of the young ones of four or five months old to their Patients, and prefer it far before Hens or Chickens.

Though this sort of Cattel be great and large (as we have said), and the Journeies long which they travel, yet they put their Masters to no charge, either in their Meat, or Shoeing, or Stable, nor in their Pack-saddles, or Girths, or Cruppers, or Stays, or other Utensils which our carriers use; for when they come to the end of their days journey, they only throw off their burthen, and send them to feed on the Grass which the Land affords, being at no charge, either of Straw or Corn, though they would gladly eat Corn, if their Masters would be so kind as to bestow it upon them. Then as to their shoeing there is no need of it, for besides that they are cloven footed, they have a kind of a callous, or spongy matter on their Feet, without a Hoof. Then for their Pack-saddles they have no need of them, because they have so much wool on their Backs as serves in the place of a Saddle, and keeps the burthen fast and close, which the masters of them take care to lade in such manner, as that it may lie even, and well poised, and not touch so far as to gaul the Withers; nor have they need of a Surcingle which our Carriers use, for the Beast wearing no Pack-saddle, all Girths or Cords may rub off the flesh; howsoever many of them travelling in a Drove were tied one to the other, having 20 or 25 beasts running loose, so as to ease and change the Burthens of those which were tired. The Merchants in travelling carried their tents with them, which they pitched in the Fields, wheresoever they found it convenient to lodge and repose; and there unloaded their Merchandise; so that they never entered into Villages or Towns, because too much time and labor would be lost to put their Cattel to Grass, and then to go and fetch them up."

While this is an excellent translation of the description written by Garcilaso de la Vega nearly three and a half centuries ago and gives a good idea of the uses to which the animal was put by the natives of Peru, Bolivia, and Ecuador, it may be well to supplement it with the following details as to the size, structure, and a few other prominent features of the llama. The ordinary height of the animal is from 4 to 4½ feet at the shoulder, although exceptionally fine specimens reach a height of 5 feet, while the length of the body is about the same. Owing to the long neck and lofty head he appears taller than he really is. The eyes are large, black, rather prominent, and usually soft and expressive in appearance. The muzzle is rather long and somewhat pointed, the snout dark or mouse colored, nostrils nearly always dilated and situated considerably above the end of the snout. The upper lip is cleft, like that of the camel or hare, with a split wide enough to reveal the fore teeth when the animal feeds; the lower lip is generally pendulous. One incisor and one canine tooth are found on each side of the upper jaw, but in the lower there are six incisors and two canine, while five grinders are inserted on the two sides of each mandible.

The ears of the llama are pointed, about 4 inches long, the edges generally tipped with white, and quite hairy within. When the animal is in active motion the ears are nearly always carried erect, like those of an alarmed horse, but when lying down or in expressing resentment the ears are couched backward on the head. The head is covered with a soft, mouse-colored down, very short and fine toward the end of the muzzle. The neck is from 2 to 2½ feet long, slender, arched, and in motion resembles that of a swan. The body is much like that of a fallow deer in shape, but tapers greatly at the loins, like that of the greyhound. The animal is very clean-limbed; the hoof is cleft and the fore parts are armed with two indurated, black, horny, hooked spurs, somewhat resembling the talons of a bird of prey, which serve to support him on the snow-covered rocks and steep declivities of his Andean home. His feet are large, the soles being somewhat round and composed of a soft substance, and from the fetlock down are very pliable.

The tail is 8 or 10 inches long, the fleshy part much smaller than that of a sheep, and is covered with wool and hair mixed, the latter predominating. Only when

aroused and gambolling in his pasture grounds does the animal carry his tail raised; at other times it is carried "tucked in" or pendulous. The whole body is covered with a soft coat of woolly hair that does not curl or drop off as does that of the camel. The most and finest wool, as well as the least mixed with hair, is on the back and rump of the animal, while the longest hair is found on the flank and on the center part of the belly. In color the llama varies about as much as does the horse, light brown, dun, gray, dark brown predominating, but under the belly he is uniformly white.

The llama, as well as the three other species of the genus, ruminates and chews its cud as does a cow. Like the camel, it is capable of abstaining from drink for a long time, instances being known where the only moisture it received for weeks at a time was from the green food consumed. The meat of the kid llama is quite palatable, having the taste of young goat rather than mutton, but as the animal increases in age the flesh becomes tough and more or less tasteless. The female has usually only one kid, and the limited quantity of milk secreted by the mother is generally only sufficient to nourish its young, so that llama milk has no domestic uses. Its wool is much inferior to that of the alpaca, although it has sometimes been used as an adulterant by mixing it with the alpaca shearings. For practical purposes the llama of today, like its progenitors of the times of the Incas, is used as a beast of burden, and its chief value is found in that sphere rather than as a source of supply of either meat or wool.

The alpaca, the second domesticated species of the genus *Auchenia*, was known as the "paco" (sometimes as "paco-llama") among the Peruvians. No doubt the connection of the Spanish definite article "el" with the name "paco" is responsible for the present version, "el paco" having been corrupted to "alpaca." In structure and general characteristics it closely resembles the llama but with sufficiently pronounced differences to make it a distinct species. While the llama may be crossed with the alpaca, just as in the case of the horse and the ass, the progeny is sterile. In height the alpaca seldom reaches 4 feet, and the length of the body is proportionately longer than is that of the llama. The neck is not as long, as slender, nor as arched as is that of the llama, but when divested of its fleece its body resembles that of the latter animal, especially in the small, tapering waist. It has the cleft lip, but unlike the llama the upper gums are of a jet-black color. The head more nearly resembles that of a sheep, while the ears are nearly always held erect. The snout, not so long or so dark as that of the llama, is less pointed; the nostrils are not so dilated and are not placed so high. A further peculiarity of the animal is that its hind legs are smaller than the fore legs; the foot is cleft, like that of the llama, with hooked spurs, but proportionately smaller and more delicately constructed. The alpaca ruminates just as does the llama, but it is the only one of the four species of *Auchenia* that does not express its resentment by spitting its moist cud at the object of its anger.

Owing to its long, glossy fleece the alpaca is the most important and most valuable of the South American camels. It is because of the abundance of this long fleece that the animal looks so much fatter than the llama or its wild relatives, the guanaco and vicuña. It hangs in long, more or less tangled, strands down the sides, rump, and breast, the strands being from 8 to 12 and even at times to 16 inches in length. This fleece is of a variety of colors, ranging from white through varying shades of dun, cinnamon, brown, to black, individuals being frequently of mixed color. In this connection it is interesting to note that the Incas, who possessed great flocks of these animals, segregated them by colors, evidently to prevent in the easiest manner the mixing of different colors at shearing time. In regard to this practice Garcilaso de la Vega wrote:

"To discriminate the immense number of these sheep kept on their estates by the Incas, the flocks were divided according to their respective colors. The parti-colored one was called *murumuru*, and if from it a fawn was born differing in color from its dam, it was taken away as soon as weaned, and put to pasture with the flock of its own color. In this manner they distinguished their herds, keeping an account of them by means of the quipus, or knots with which they counted, the threads of which were of the same color as the flock. In the highlands clothing was made from paco wool, which the Incas ordered to be collected from their estates and distributed among the people, who manufactured three kinds of cloth, viz., the *havasca*, the coarsest quality, used by the lower classes; the *cumpli*, a second class, worn by the nobles and public functionaries; while the third and finest cloth was reserved for the royal family and their favorites. The

finer qualities were of all colors and of various designs; women spun the yarn and wove the coarser kinds, but the finest were made by men."

Early in the nineteenth century Mr. William Walton, who had made an exhaustive study of the alpaca on its native heath, became an ardent advocate of a movement to introduce this valuable animal into the British Isles as an adjunct to the sheep industry of the country. As heretofore noted, his first work on the subject of "Peruvian Sheep" was published in 1811, and this was followed by other published addresses and pamphlets, concluding with a little work published in 1844. From this booklet we quote the following to show the estimation in which he held the wool of the alpaca, as well as for the glimpse he gives of the weaving industry of the natives of Peru:

"Of the two domesticated species, obviously the alpaca is the preferable one for our adoption. Whatever may be the classification of naturalists, the alpaca is essentially a wool-bearing animal; and of the fineness and softness of the textures made from its fleece by the ancient Peruvians we find ample testimony in the works of several of the early annalists, some of whom acknowledge that in delicacy of web they exceeded any cloths at the time manufactured in Spain. The same authorities speak in the highest terms of the beauty and permanency of the vegetable dyes used by the Peruvians, as well as of the artistic skill of the designs, and the truthness with which their cloth was made. Spinning and weaving, indeed, formed part of the domestic employment of both men and women; and, as an encouragement, the Incas kept public establishments in which the art of fine weaving was taught. D'Orbigny affirms that textures of both wool and cotton, extremely fine, and wove with perfect regularity, are still found in the huacas or sepulchral monuments of the ancient Peruvians—a proof not only of their advancement in the art of weaving, but also of the durability of the materials used by them.

"The capability of alpaca wool being converted into articles of fine texture is now established by the experience of our own artisans, as well as those of France. Fancy goods made from this material, and having a superficial luster resembling that of silk for several years past have been selling in the London and Paris shops, and are very generally introduced into Germany and other countries. In quality this wool differs from that of ordinary sheep, exceeding it in length, softness and pliability. The staple of English wools is seldom more than 6 inches long, whereas that of the alpaca averages from 8 to 12, and sometimes reaches 20, acquiring strength without being accompanied by coarseness, the reverse of which occurs in our woolly tribes. Each filament appears straight, well formed, and free from crispness, and the quality is besides more uniform throughout the fleece. There is also a transparency, a glittering brightness, upon the surface, which gives it the glossiness of silk, considerably enhanced when it comes out of the dye vat. It is distinguished by softness and elasticity, essential properties in the manufacture of fine stuffs; and being exempt from spiral, curly, and shaggy portions, when not too long it spins easily and yields an even and true thread. Neither is it liable to crotching, which renders wool adhesive and causes it to form knots, difficult to unravel in the combing process. It is not injured by keeping, nor does it lose in weight."

It was not, however, for its qualities as a wool-bearing animal alone that Mr. Walton advocated the introduction of the alpaca into Britain. He insisted that its flesh was an excellent article of food among the Peruvians, and quotes Zarate as declaring that "llama and alpaca meat is extremely wholesome, and as palatable as that of fat sheep in Castile." Walton himself comments as follows:

"The quality of alpaca meat could not indeed fail to be good, when the cleanliness of the animal, the nature of its food, and the neat and delicate manner in which it feeds, are considered. Andes sheep eat nothing but the purest vegetable substances, which they cull with the greatest care, and in habitual cleanliness surpass every other quadruped. With their flesh the Peruvians to this day prepare a jerked meat, called *charque* which, stewed with rice or onions and tomatoes, makes an excellent dish. On their farms it in fact holds the place that bacon does on ours, and also serves for a sea voyage. To prepare it the meat is separated from the bones and cut into long slips, with a due proportion of fat adhering to each, and all the coarse bits rejected. In this state it is slightly salted, dried in the sun, and then smoked; by which process, however, it becomes so hard and dry that it requires steeping in water for several hours before it is used. Andes sheep eat very much like the venison ones cured in North America, and certainly the dried tongues are superior to those of the reindeer."

For over 30 years Walton continued his efforts to interest the British sheep raisers in the introduction of alpaca breeding. It was his idea that the highlands of Scotland afforded conditions of climate and vegetation so similar to the Andean regions to which they are native that it would only be necessary to introduce a few individuals of the species to start a new industry. Numerous attempts were made at this time, and frequently repeated since then, and in a few isolated instances the animals imported survived and produced progeny chiefly in zoological gardens and on some private estates, but these successes were so few and results so poor that no tangible economic effect was produced. The llama and alpaca, not only in England and Scotland but in France, Spain, Germany, Austria, and even in Australia, in all of which countries similar attempts have been made, remain objects of curiosity rather than of commercial and economic value. Apparently the Andean regions of Peru, Bolivia, and Ecuador, and to a more limited extent of Chile and Argentina, seem to be the only parts of the world where these animals will thrive. The high plateaus of the Andes, the native habitat of the llama and alpaca, at an elevation of from 8,000 to 12,000 feet above the level of the sea, present the peculiar conditions of climate, atmosphere, and vegetation under which the organisms of these animals have been developed, and these conditions seem essential to their successful production. Their wild relative, the vicuña, thrives at even greater elevations, being found chiefly in regions that are from 12,000 to 15,000 or more feet above sea level and generally above the snow line.

For all practical purposes Peru and Bolivia are at present the principal countries that furnish the world's supply of genuine alpaca wool. In this connection the following paragraphs, taken from an interesting report on general conditions in Bolivia made by American Minister John D. O'Rear in February, 1917, give an idea of the present status of the alpaca wool industry in that country and in Peru:

"Throughout the arid region that lies between the two Cordilleras a species of bunch grass grows which is capable of resisting the rigors of winter and which provides abundant pasture for sheep and other wool-bearing animals. Experiments conducted under Government supervision seem to indicate that the alpaca is better suited to live in the highlands than is the sheep or any other wool-bearing animal. The Government of Bolivia is making a special effort to stimulate the industry, and the production of alpaca wool is attaining considerable importance in the country.

"It is customary to shear the alpaca every second year, but it has been found that the wool continues to grow for a longer period and that it would probably be profitable to shear them only every third year. The present yield averages about 10 to 15 pounds per animal every second year.

"Until recently the alpaca herds were small and belonged generally to Indians, who gave little or no attention to the improvement of the breed. Efforts are being made to improve the alpaca, and the Bolivian Wool Co., with headquarters at Porto Acosta, on the shores of Lake Titicaca, has taken the production of alpaca up in a businesslike manner and is receiving encouragement from the Government of Bolivia."

Since the publication of Minister O'Rear's report, however, the official commercial statistics of Peru and Bolivia show that there has been a very considerable increase in alpaca production, for in 1916, Peru exported alpaca wool to the value of £556,956 (\$2,709,591); llama wool to the value of £2,398 (\$11,066); and vicuña wool to the value of £47 (\$218). The latest figures available from Bolivia show an export from that country of alpaca wool to the value of 162,605 bolivianos (\$63,415) and of vicuña wool to the value of 11,978 bolivianos (\$4,671).

The guanaco, sometimes written huanaco, is the larger of the two wild species of *Auchenia*, but smaller than the llama. Its habitat is more extensive than that of the llama, or for that matter of any of the other species, for it is found from the higher elevations of the Andes of Peru and Bolivia down to the southernmost sections of Chile and Argentina, considerable numbers of guanacos having been found even beyond the Strait of Magellan on the island of Tierra del Fuego. Some authorities hold that the llama is merely a domesticated variety of the guanaco, while others insist that the differences between them are sufficient to constitute each a species. Walton, who made a very thorough study of these animals, held that they are distinct species and notes the following characteristic differences:

The height of the full-grown guanaco is but seldom over 3½ to 4 feet, and, like the alpaca, the body is longer in proportion to height than is that of the llama;

its color is invariably a reddish brown, although a few instances of white individuals have been recorded; the back of the guanaco is somewhat more arched than that of the llama, its coat shaggier, its feet smaller, face rounder, snout shorter, body less tapering at the waist, and the callosity on the sternum which characterizes both the llama and alpaca entirely wanting. Naturally also, the whole bearing of the wild animal is more alert and aggressive, and instead of timidly yielding an old male guanaco will fight and spit its cud at an enemy upon the least provocation.

In recent years the guanaco seems to have thrived remarkably in the colder regions of what was formerly known as Patagonia, in southern Argentina. In fact, about six years ago the sheep raisers of certain sections of the Territory of Santa Cruz found that the guanacos were becoming so numerous that they were devastating large areas of sheep pasturage. A conference was held between the chief of the Division of Animal Industry of the Argentine Department of Agriculture and a number of prominent southern ranch owners in order to devise some means of meeting the situation. It seems that the price of guanaco skins had fallen so low that it was no longer profitable to hunt the animals, hence their rapid multiplication. The result of the conference was a recommendation to the minister of agriculture that efforts be made to utilize and to domesticate the guanaco rather than to attempt to exterminate it as a pest. It was suggested that prizes be offered to tanneries, textile mills, and furriers' establishments to stimulate the better and more economical preparation of the hides and wool, and that the meat be utilized in some way, even if only as food for other animals. As a consequence of this conference the Argentine Department of Agriculture is making experiments at several of its stations to domesticate the animal. Sufficient time has not yet elapsed to determine whether these attempts will prove successful or not, but if they do there is no question but that a valuable addition to the animal husbandry industry of the country will result.

The vicuña, the smallest of the genus *Auchenia*, is fast disappearing notwithstanding recent efforts of the Peruvian and Bolivian Governments to protect it. In stature the animal is rarely over 3 feet tall, while the length of the body is about the same. It has the same arch in the waist that characterizes the llama; its head is larger in proportion to the size of its body, is rounder and tapers suddenly to a small snout and very small mouth with the usual cleft upper lip. The forehead is higher, and the whole head is covered with a longer and curlier down than is that of the llama or alpaca, and its color is invariably a reddish brown. The nostrils are small, teeth similar to those of the other species, and the upper gums, like those of the alpaca, black in color. The limbs are slender and delicate and seem excessively long for the body; the small feet are cleft and have spurs on the fore part similar to those of the llama. The fleece of the vicuña is uniformly of a russet, or reddish brown, color and is finer, silkier, and more valuable than is that of even the alpaca. It extends from the fore shoulder all along the back, rump, and upper flanks, comparatively little hair being mixed with the wool, except under the belly, where the hair grows longer and the fleece is of a whitish color.

The animal inhabits the loftiest regions of the Peruvian, Bolivian, and Ecuadorian Andes. It is extremely timid, has never been domesticated except in rare instances when caught extremely young and raised as a pet in some native family, and has been the prey of the hunter from the earliest Inca periods down to the recent years when the above-named countries instituted legal measures for its protection. Owing to the laws against hunting the vicuña and killing the timid creature for its pelt, and to its greatly diminished numbers in accessible regions, the export of its beautiful fleece has become negligible.

Annealing Aluminium

At a recent meeting of the British Institute of Metals Mr. Robert J. Anderson urged consideration of the possibility of abbreviated exposure at various temperatures being able to confer workable properties upon cold-rolled aluminium sheet, with less fuel, in a shorter time, and with a smaller percentage of defectives in the subsequent drawing.

He gave particulars of a number of experiments in which various gauges of cold-rolled aluminium sheet were exposed for three minutes at a series of temperatures varying from 400 to 500 deg. C. He concluded that exposure to 370 deg. for 24 hours, as usual in commercial mill practice, is unnecessary, and that the lighter gauges can be softened by such an abbreviated exposure as three minutes at 400 deg. He stated that tests in the mill have demonstrated that aluminium

softened by short exposures to heat fulfils the draw-press requirements, and that the percentage of defective shapes is smaller than with similar metal annealed for, say, 24 hours at 370 deg. In the manipulation of certain shapes by the draw-press the sheet is ordinarily cut into circles or other geometric patterns and annealed before being drawn, and in one instance the number of defective shapes was observed to be 30 per cent. out of 4,400 blanks drawn, the metal having been annealed by long exposure. As a test of the effectiveness of long annealing, 200 cold-rolled No. 22-gauge circles were annealed for three minutes at 475 deg. and drawn by a typical draw-press operation into a given shape; only one defective shape resulted from rupture in the press, or a scrap loss of 0.5 per cent. Other tests on sheets of various gauges which had been annealed for relatively short times, ranging from 5 to 60 minutes, gave scrap losses of less than 1 per cent. in all cases. He pointed out that if the annealing can be effected by relatively short exposures, a continuous annealing furnace for aluminium becomes not only possible but is definitely assured, provided certain minor details of a mechanical nature, which should present no great difficulty, can be overcome.—*London Times Engineering Supplement.*

Big Mercury-Vapor Rectifiers

A PLANT of largest size mercury-vapor rectifiers was installed two years ago by Messrs. Brown, Boveri & Co., of Mannheim, in the small town of Hirschberg, in Silesia, to replace the old rotary converters. According to J. Obach (*Elektrotechnische Zeitschrift* of October 17 and 24, 1918) the plant operates very well, although there were some troubles in the first months. The town receives three-phase currents of 10,000 volts from the provincial electricity works. These currents were transformed into continuous currents of twice 220 volts by rotary converters, the conversion efficiency being 0.85 per cent, at full load and 0.65 per cent. quarter load. Batteries were further wanted to take the peak load, and in 1913 the losses in batteries, cables and meters amounted to 19.5 per cent., and the total losses (partly borne by the average load being only 5 per cent.) by the town to 45 per cent. When an enlargement became necessary various modifications in the system were proposed, but mercury-vapor rectifiers of the Hartmann-Schäfer type were finally adopted, although there was little experience available with large-size apparatus of this kind. The three cylinders, each working with 48 kilogs. of mercury, deal with currents of 750 kilowatts. The mercury is contained in the lower portion of the cylinders, while the cooling devices for the electrodes are in the upper portion, on the top of which the arc-striking device is mounted. The anodes are of iron and suspended from a ring; a vacuum of 0.005 mm. of mercury, measured by a McLeod gauge, is maintained on the cylinders. The cooling is necessary to prevent loss of mercury; these losses amounted altogether to 1.8 kilogs. in the first half-year, and the average efficiency of the conversion is said to exceed 90 per cent. It is not quite clear what this efficiency signifies. The installation is considered very successful, however.

Action of Laundry Agents on Textiles

AFTER 30 washings with hard soap, soda, sodium silicate and perborate, respectively, linen and cotton textiles showed higher strength values with hard water than with soft water. With soft water sodium silicate showed a distinct injurious action on cotton, and perborate was still more harmful. Goods washed with soap improve in lustre and show a brilliant white color by reflected light; goods washed in soda show a strong yellowing in transmitted light with a slight shade of pink; by reflected light they appear slightly grey. After washing with silicate the goods are white but quite without lustre, being dull and chalky. The handle of goods washed with soda or silicate is very poor. The loss of tensile strength suffered by textiles in washing is not a simple measure of the changes which have taken place in the fibres. In estimating the loss of quality the external appearance of the fabric must be taken into account and particularly the splitting of the fibres as observed microscopically. Perborate in presence of soap is decomposed with equal rapidity in distilled and in tap water. Soda slightly retards the decomposition; silicate makes a solution of perborate in hard water practically stable and has some influence in the same direction in cold distilled water. The alkalinity of perborate solutions is of little importance compared with the rapidity with which they part with their oxygen.—*Note in J. Soc. Chem. Ind. on an article by A. Grün and J. Jungmann in Seifenfab.*

Manufacture of Charcoal as an Economic Measure*

A Valuable By-product Readily Made from Lumber Mill Waste

By Helge Sylven

In the United States, as well as in all other countries, the great war has created many new industries and opened up possibilities for marketing products in a manner that had not even been dreamed of a few years ago. New and improved methods have been worked out and applied in all industries. A great many of the old systems of doing things have been discarded, to be replaced by the creations of this new spirit of the times. Even the lumber industry has been influenced to some extent by these changing conditions; in fact, it may be said that the lumber industry is rapidly approaching that milepost on the road of its development where it will have to face more or less of a revolution in the methods of financing and planning new operations. This includes the necessity for utilizing some



Preparing a stack in the woods

of the more than sixty per cent. waste of the log that enters the saw mill in such a manner that it can be sold to produce more profit than when a part is marketed as firewood, while the greater part is more or less expensively disposed of in a burner.

Hitherto all attempts at the utilization of Douglas fir waste by distillation have given negative results. This does not go to prove that distillation is impracticable; these failures have undoubtedly been due to a lack of technical supervision, the use of an inefficient and visionary apparatus, the production of products that were unmarketable, and perhaps, above all, the inability to handle the commercial or financial part of the industry—something that has been very apparent in the astounding lack of interest in the creation of markets and the improvement in existing markets for the products of distillation.

For years the government of the United States, laboratories and educational institutions have been, and still are, working on how to find a solution for the wood waste problem. At present there is much interest in methods of land clearing, and here the problem of the utilization of the great stumps that must be removed has received some attention. It has been proposed to use these stumps in distillation plants for the production of charcoal and by-products. Much experimental work has been done along this line.

So far as the scientific part of wood distillation is concerned, a great deal of work has been done for the business men who are in the lumbering industry and it is up to them to put this information into practical use. Still, however completely a new venture has been analyzed from a theoretical standpoint, a business man will always hesitate to enter the field. Somebody must, however, always be the pioneer in any industry. Often there are several pioneers. The Bessemer process of manufacturing steel was taken up by pioneer after pioneer, so to speak, but due to the lack of technical advice on the part of these successive pioneers, the process was considered a failure. Finally, however, Bessemer's process was taken in hand by a group of Swedish metallurgists, who, after a little thought and experimentation, made the Bessemer process the king of steel producing methods. The result was, of course, that they were reimbursed for their work beyond their most sanguine expectations.

In wood distillation and the utilization of wood waste in general, Sweden is the pioneer country, and the country from which the most valuable information can be obtained. In that country, wood distillation, with the chief purpose to produce charcoal, has been almost the regulating factor in forestry practice for hundreds of years. In the following article I will try to present the essential points of the Swedish wood waste industry, in which I have been personally en-

gaged, and which I have studied more or less intensively.

Before touching upon any of the methods employed in that country, I feel that it would be well to bring out a few facts and data regarding the country itself and its forestry in general.

Sweden is a little larger than Washington and Oregon combined. Embracing an area of about 173,000 square miles, it occupies the major portion of the Scandinavian peninsula, the most northerly fraction of the European continent. The country is populated by 6,000,000 people. Half of its area, fifty million acres, is covered with forest; 80 per cent. of conifers (pine and spruce) and 20 per cent. of hard woods. As a comparison, it may be of interest to mention that the forested area of the United States is 545,000,000 acres. The Swedish forests yield annually more than 40,300,000 cubic metres of timber, which is equal to about one-third of the annual cut of the United States, and is more than three times as great as the cut of Washington and Oregon together.

As mentioned above, the distillation of wood has been known in Europe for several hundred years. In the early days the distillates, tars and oils, were not at all utilized, only the charcoal being considered of value. The production of charcoal is still the chief purpose of the distillation industry in Sweden, although during the last two centuries many of the plants have been equipped so as to save the valuable by-products.

Excepting a few consumers of more or less importance, the pig iron industry consumes all of the charcoal that is produced. In the smelting of the remarkably pure Swedish iron ore, coke is not desirable, as coke always contains impurities that lower the quality of the iron. Charcoal, which is nearly pure carbon, is therefore used for this purpose. Thus the utilization of wood waste has become an industry in Sweden that is intimately connected with the mining industry, and which is of the greatest economic importance.

The charcoal industry is of importance, however, in many other respects. It pays the expense of clearing the woods from windfalls and debris, which otherwise would remain as a fire hazard and hinder reproduction. It makes it possible to apply conservative methods in logging and forestry in general, by utilizing the small trees obtained in thinnings for charcoal. In economically utilizing the vast quantities of defective and dead trees in the virgin forests in the northern part of Sweden, the charcoal industry plays the same important rôle. An estimate made by the forest committee in 1896 showed that in northern Sweden alone, about 4,250,000 cubic meters of wood could be saved yearly, if utilized by charring. The above mentioned committee also urged the building of a railroad through the northern province of Sweden, which is known as Norr-

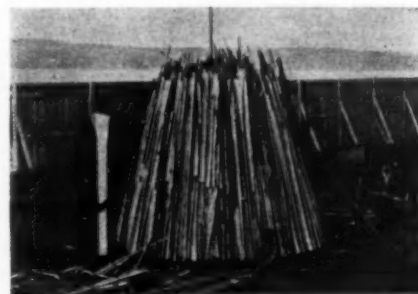


Covering the stack with boughs

land. The construction of this railroad began a few years ago, and the work on it is rapidly progressing. The length of the finished railroad will be about 600 miles, running through the richest mining and forest districts of the country.

Another point of importance in the charcoal industry is the fact that in Sweden it gives steady work and stable wages to a great many laborers. It constitutes the best source of income for the forest owning farmer, and for the new settlers in northern Sweden the extra income through the charring of wood is of vital importance. In connection with this I will take the opportunity to mention how the big manufacturing estates and iron works get their supply of laborers.

These concerns as a rule own large areas of timber and farming land. To secure a good supply of labor, part of the estate is divided up into small units of a few acres each. These small units or farms, which are equipped with the necessary buildings, are rented to people who wish to settle down. Some financial help is given the new settler to enable him to buy horses, a few head of cattle, and farming equipment. The settler pays his rent by doing a certain amount of work in the woods of the state. By contract, he is required to produce a certain amount of charcoal each year. If his output exceeds a stipulated amount he is paid cash for the excess. This contracted work does not take



Preparing a stack of mill waste

more than three or four months of his time each year. Thus he has plenty of time to attend to his private business. On these small farms, eight to ten cows, two horses and a few sheep and pigs can be kept, and with his spare time the settler has an opportunity to earn considerably more extra money by driving logging teams or in other work for the company that owns the estate. On account of the good extra earnings these farms are very much in demand, and generally, when once settled, the family remains on the estate for generations.

In recent years, however, on account of the increasing charcoal production, scarcity of skilled labor has been experienced. As a remedy for this condition several of the biggest companies undertook to establish charring schools, where the students are given free room and board while under instruction.

At the present time about 20,000 men are employed in the charcoal industry; in the logging operations about 100,000 and in the lumber business as a whole about 300,000 men. One can safely say that 1,000,000 people make their living on the forests of Sweden.

Like all other forest products, the price of charcoal is increasing year by year. At present it is enormously high. Naturally it follows the price of pig iron. Previously to the war the comparative prices of charcoal and pig iron were as follows:

One ton of pig iron..... 76 crowns (\$20.00)
One cubic meter of charcoal... 6.6 crowns (\$ 1.78)

It is estimated that it takes about six cubic meters of charcoal to produce one ton of pig iron.

Charcoal operations are carried on either as "woods operations" or as "mill operations." In the "woods operations" the wood is charred in stacks in the woods. The advantage of the woods operations lies in the fact that timber that is located in comparatively inaccessible places can be converted into charcoal, which can be more readily transported, as it weighs only one-fifth as much as wood. Instances where the charcoal is hauled from ten to twenty miles are quite common.

"Mill operations," as the name indicates, are always located at a saw mill or at some point that is close to a waterway or a railroad, where transportation facilities are such that the cost of handling the wood is low. This classification includes any kind of permanently established charcoal works. The advantages of mill operations are: 1. Mechanical means of transportation can be used; 2. The valuable by-products—tars and oils—can be saved and used; 3. The dependence on skilled labor is more or less eliminated. About twenty-five of the biggest plants in Sweden are using ovens or retorts. The rest, about 90 per cent of all charcoal producers, produce charcoal by the old system, which requires very little capital outlay.

*Courtesy of the West Coast Lumberman.

In "woods operations" stacks are used exclusively. A charring stack or "milla" consists of a pile of wood stacked up on the ground out in the open and covered with sand, mixed with charcoal-breeze. I will here give a short description of a charring operation on a manufacturing estate where I had the opportunity to take part in every detail of the work.

This operation was located in the well forested middle part of Sweden, and the object was to utilize a fire-killed stand of young pine and spruce, in admixture with birch. The burned-over area covered about 20,000 acres. The stand was very dense and was composed of trees with an average diameter, breast high, of ten inches. About 20 per cent. of the trees were hewn into railroad ties immediately after the fire. The remaining 80 per cent. were utilized by charring.

Means of communication in this part of the country are very inferior, and it was only with the greatest difficulty that we were able to construct simple trails over the rocky and hilly ground. The nearest railroad station was twenty miles away. However, the rising, all of a sudden, of charcoal prices, made it possible to spend some extra money on transportation equipment.

The charring operation started soon after the fire, as it was important to cut the trees before decay caused too great a loss. Thus the work of charring was undertaken on a very large scale, with a calculated yearly cut of one-third of the stand.

Naturally, there were not enough hands available on the estate to handle this big operation. The hiring of new laborers was therefore accomplished through employment agencies and by advertising in the newspapers and trade journals. All work was done by contract, with the exception of supervisory work by foremen, and work done by the permanent settlers on the estate.

The burned-over area was divided into small sections, each large enough to furnish wood for a single charring stack. The charring stacks ordinarily made in Sweden are usually 27 meters in circumference, so that when the ten-foot lengths of wood are stacked on end to cover this area, the stack will contain 168 cubic meters, or 100 cubic meters of solid wood. The height of the stack is therefore ten feet.

As the men arrived in the woods and the cutting was started, small cabins were built for their housing. One cabin was built for each fifth section and spaced about one mile apart. This work was done either by the hired men themselves, or by a certain cabin building crew of the company's own men. The cabins were of very simple construction and intended only for temporary use. They were made of solid logs, with the bark removed, and were covered with sand or dirt. Each one was furnished with an open fireplace, built of rocks, and in each one there was room for two to four men. These cabins were not at all unpleasant to live in, and the men mostly seemed to find such a life quite enjoyable. They very seldom worked for more than seven hours a day, or as long as they needed to make at least five crowns (\$1.25) a day. In many cases they earned twice that amount and even more. Their living expenses did not exceed one and a half crowns (38 cents) a day, and as they had no chance to spend money otherwise, they were able to save quite a little, making them feel satisfied with themselves and everything.

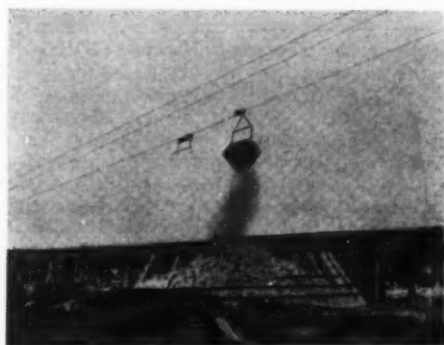
Food was furnished to the men by the company at cost, and was brought up into the woods twice a month. The company supplied all tools except saws and axes. The woods foremen kept records of the work and rendered an accounting every month. They also acted as paymasters. Each foreman was in charge of thirty to forty charring stacks. Besides this, his time was occupied with various kinds of forestry work in the green timber. The head ranger of the estate was in charge of the entire operation. In Sweden, a "head ranger" is a combination of a supervisor and a logging superintendent.

As mentioned before, the cutting was started early in the spring thaw, and was continued during the summer until late in the fall as long as the ground was bare of snow and ice. When the men arrived the foremen directed them to their cabins and put them to work, one man to each section. Each man was supposed to clear-cut his section in fourteen days. He was not allowed to leave anything on the ground. Even the smallest brush had to be cut, and the ground cleared of all windfalls and debris. All trees were bucked up into ten-foot lengths, and put up into piles four feet high. The piling had to be done carefully, partly to hasten the air-seasoning of the wood, and partly because the payment plan was based upon the volume of wood that was cut. Each pile contained from five to fifteen sticks. The average capacity of a man was six such piles each hour. To accomplish this he had to work speedily and systematically, always keeping his tools sharp and in good order. The axes used in this

work should be light and easy to swing with one hand. When finished, every stick should be smooth and free from branches, so as to fit well with the other sticks when piled up into the charring stacks.

When green timber is cut for charring, the bark is usually partly removed to hasten the seasoning, but in our case this was unnecessary, because the fire-killed trees were already fairly dry.

When a considerable number of sections had been cut, the carrying of the wood to the charring stacks began. This was done by means of horses and sleds, so-called summer sleds, with a capacity of about one cubic meter to the load. The charring stacks were then piled up as the wood was brought into the place. Two men with two horses were able to haul enough wood for one stack in two working days. A third man



Conveyors carry waste to the stack

piled up the sticks. Before the piling was started the ground was prepared and the "bottom" was laid out. The "bottom," or the ground under the pile, was given a circular form, shoveled even and free from all rocks and stumps. This is of importance to enable one to properly control the temperature in the stack.

The stacks were built up in the following way: In the center of the circular area or "bottom" a nine-foot pole was erected and supported by three other sticks. The center pole should always be a little shorter than the sticks that are to be placed in the stack. Near the top of it, two wedges, two feet long were driven in horizontally and perpendicular to each other, forming a frame for the hole or flue through which the wood in the stack is ignited. The ten-foot lengths of wood were then piled up on end around this center pole until the edge of the circular bottom was reached, giving the stack the appearance of a frustrum of a cone. If the wood was dry, the next step was to cover the stack with a mixture of earth and charcoal breeze. Instead of charcoal breeze, sand can be used. Sawdust has been



Firing the Stacks

successfully used when mill waste is charred. It may be mentioned that before the stack is covered with earth, the top of the stack should be covered with spruce branches, straw or moss, to keep the earth from running down between the sticks.

In the beginning of October, when the fall rains had removed the danger of forest fires, the kindling or igniting of the stacks was started. The stacks are kindled through the channel that runs up from the bottom of the stack along the center pole. This channel or flue is therefore filled up with the dry kindling wood, which is ignited. The top of the flue is then covered with earth. This is repeated two or three times, until the stack is hot enough to keep on charring by its own temperature.

The development of the charring process must be closely watched. The heat is regulated by making or closing up airholes at the ground line of the stack. The progress of the charring, which proceeds downwards in the stack, can be inspected with a long iron bar. After a few days a large amount of gases develop, which sometimes burst through the cover. The top cover should then be thinned off to make it easier for

the gases to escape. Draft holes, which are pierced through the cover of earth just below the charring zone, sometimes serve for the purpose. The relation between the air holes and the draft holes is of great importance, as they direct the gas currents and check the temperature in the stack. It is up to the man in charge to see that the holes are properly spaced and regulated, so that the charring is not done too quickly, which would lower the quality of the charcoal. Ordinarily the burning of an ordinary charring stack takes two to three weeks. When all of the wood in a stack is charred—which can be determined by the transparency of the smoke issuing from the draft holes—all holes are plugged up and the stack is left to cool for several days. The stack is then opened and the charcoal raked out into a wide circle on the "bottom." This circle of charcoal has to be watched for about ten hours, as the charcoal has a tendency to spontaneously ignite, due to its gas absorbing properties.

The charcoal also absorbs water easily, and as a high percentage of water lessens the quality, it should be placed under shelter as quickly as possible to haul it to the railroad station on large sleds.

The above description has referred only to the usual method of conducting a "woods operation," where the chief object is to produce charcoal. Under the term "mill operations" are included all permanently located charring works, which are usually ovens or retorts, though on many occasions stacks are used, but on a larger scale than in the woods. Through a different method of preparing the "bottom" of the stacks in such permanent installations, some of the by-products can be obtained. The accompanying sketch shows how stacks are used in "mill operations." The stacks are charged with slabs and other mill waste by means of overhead cable-ways. One man is able to run the whole business for long periods.

The biggest plants, however, almost exclusively use retorts and ovens, which of course under normal conditions and when an abundance of wood waste is available is the most economical method. The first charcoal oven built in Sweden dates back to the beginning of the seventeenth century, when Funk built his first brick oven. Since that time several inventions and improvements have been made along the same line. No less than eight different types of ovens are in use in Sweden at the present time. The retort-wagon oven with indirect heating is considered a very practical and economical type. The American retort methods were discarded long ago, as they were too expensive to run and keep up. One of the best distillation plants is undoubtedly Dr. Grondal's progressive charcoal kiln, which is constructed on the same basic principles underlying the Swedish retort-wagon oven type, but differing from it in that it is continuous in operation, so that large quantities of wood can be rapidly and cheaply charred, at the same time saving all of the by-products.

It would take too much space to explain in detail how the ordinary oven works, but for those who are not familiar with the main principles of retort charring in general, I will give a few points that may be of interest. The retort usually consists of a cylindrical or rectangular iron or steel chamber, furnished with the necessary drain pipes for distillates. The dimensions of the retorts vary, but as a practical rule they are not made smaller than three feet in diameter and ten feet long, though from a theoretical standpoint the yield is better the smaller the apparatus. The wood that is to be charred is put into a retort through a charging door at the front end. The heat from the furnace is applied by direct or indirect means to the charge. A gradually increased heat produces less gases and more liquid matter.

To get a good quantitative and qualitative result the retort should be constructed with provision made for uniformity of distribution of the heat from the furnace and for sufficient control of temperature and a proper removal of the distillates. For economy of operation, one should see to that the plant is built in an up-to-date manner with local conditions in mind, but with provisions made for future expansion. The machinery should of course be automatic and the plant as a whole continuous in operation. Fuel economy and plant maintenance also should be taken into careful consideration.

The chief products obtained by the dry distillation of Swedish pine and spruce (mill waste*) are as follows:

Charcoal	30 %
Wood tar	7 %
Acetic acid	3 %
Methyl alcohol	1 %
Acetone	0.1 %

*per cent. of dry weight of wood.

Providing it is completely carbonized, the yield of charcoal is equal for all species, or about 30–33 per cent. of the dry weight of the material charred. The volume and density, however, are quite variable. Spruce-coal cracks considerably. Therefore its shrinkage when carbonized is less than that of pine, which cracks only a trifle, and still less than birch which hardly cracks at all.

The liquid distillates obtained during the charring process pass from the retort through a pipe system to a set of tanks, where the wood-vinegar (pyroligneous acid) is separated from the tars. The wood-vinegar then goes to the rectification department and the tars to the tar distillation department, for purifying and further transformation into the final products desired, as for example gray acetate of lime, which is the raw material of acetic acid factories. Wood alcohol thus produced is sold under such names as "Columbian Methanol," "Diamond Methyl," etc., and is used in the manufacture of shellacs and varnishes, in soap manufacture, etc. Acetic acid is used in a number of chemical industries. From acetone is produced chloroform and iodoform, and it is also used in powder factories and in the manufacture of photographic films. Wood creosote produced from the tar is used for wood preservation and in a very purified form for medicinal uses. The valuable vapors are condensed in the usual way.

Another feature of the Swedish wood distillation industry is "stump-charring," which during recent years has developed into a real wholesale method of land clearing. The stumps are charred in specially constructed retorts. The returns in this stump industry are very large. The stumps, especially those of pine, are in very great demand by metallurgical factories as an excellent fuel, and by turpentine and tar manufacturers.

The utilization of sawdust also has been carried out advantageously in Sweden. One method that was patented some time ago, is to press the sawdust into bricks, which immediately are put into a charring apparatus and converted into charcoal. The by-products are the same as those obtained from ordinary wood.

For the utilization of tops and branches, a machine has recently been constructed, and it has proved to be of great value. Its construction is very simple. It consists of a wooden case and a rotating knife, which cuts wood pieces up to 4 inches in diameter into short lengths. The work is done in the woods. The advantage of the invention lies in the cutting down of the transportation costs. The wood thus prepared constitutes an excellent fuel.

The parts of this article touching on the technical and theoretical side of the distillation machinery and charring processes have been given only a very brief consideration. The chief object of the article rather has been to awaken an interest in the subject among the lumbermen, and to make it known that the blame for previous failures cannot be put on the distillation industry itself but rather on the unfortunate fact that so little about the development of the industry has been known by the pioneers along this line in America, and their neglect to consult experts on the matter.

In the United States it is mostly the "hardwood" that has been used for distillation. The principal hardwood distilling states are Pennsylvania, New York and Michigan, and the species used consist principally of beech, maple and birch. Although the hardwood has been most favored, the distillation of softwood has recently been started to some extent in connection with other lines of manufacture of forest products, and indications are that there will be a considerable growth along this particular line in the near future. The most prominent states in this respect are Florida, Georgia and North Carolina. The material used has been mostly longleaf pine.

In times to come the wood waste industry will show itself to be of a much more wide-embracing importance than the majority of us would be able to conceive of at the present time. It will give rise to many new industries and create work for thousands of people. It will help to solve the land clearing problem and in this connection the settler program. And when the soldiers return from the battlefields it can give plenty of work to many of them. When Siberia's huge forests have been opened for American business men the charcoal industry and wood distillation should be of very great value as a part of the scheme for the proper organization and establishment of the Siberian trade. It is, however, not only the lumbermen and foresters whose interests are affected by the wood waste industry, but as a matter of fact the whole business world and nearly every industry will in one way or another have the benefit of the same.

At the chemical engineers' Baltimore meeting in 1916, Mr. Arthur D. Little expressed this point of view in the following manner:

"When the real work of wood waste utilization has once begun and attention of chemical engineers and financial men has been drawn more generally to the huge potential values now ignorantly thrown away, we may expect the rapid development of these by-product industries and in initiation of many new ones to the great enrichment of the South and in somewhat less degree that of the Northwest."

It would doubtless be too sanguine to expect the directive impulse for this new development to come from the lumbermen themselves. They are too close to the wastes. They are blinded by the sawdust. But if they fail much longer to grasp the opportunity which has been so long beside them they must be content to see others reap the benefits and profits which will come through control of processes, special apparatus and above all, of technique.

Spitzbergen's Minerals

In the Treaty of Brest Litovsk there is a significant clause to the effect that Germany should be allowed to proceed with the complete organization of Spitzbergen in accordance with German proposals. What was exactly meant by this clause is a matter of speculation, but it is presumed that Germany's purpose was, in co-operation with Russia and Finland, to secure access to the ice-free port of Kola, by way of the Murman railway, and thereby establish independent communication with Spitzbergen, where, according to expert reports, are to be found the richest and largest undeveloped coal and iron deposits in the world. If that was Germany's purpose, it has been frustrated by the action of the Allies in taking possession of Kola (the terminus of the Murman railway) and by the action of the British Government in assuming effective occupation of the principal ports and a large part of the habitable area of Spitzbergen by means of an expedition, which was despatched by the Northern Exploration Company, Limited, under the authority of the Foreign Office two or three months ago, and which is now permanently established in Spitzbergen. This expedition was under the control of Mr. Salisbury Jones, managing director of the company. Questioned as to the climatic conditions of the country, Mr. Jones said that they were healthy in the highest degree, particularly on the western side, where most of the British properties were; the cold was dry and bracing, and mining operations could be carried on in comfort for a least six months out of the year. As for transport facilities, there were deep and sheltered ports, only 400 miles from Norway and 1,200 miles from North Britain. Already this year upwards of 120,000 tons of shipping had been employed in the transport of coal from Spitzbergen to Sweden and Norway.—*Morning Post, London.*

Gas Fired Melting Furnaces without Crucibles

The Central Powers have been experimenting with furnaces of the above type owing to the impossibility of obtaining graphite for crucibles. In one plant of this kind, says the *Zeitschrift des Oesterreichischen Ingenieur- und Architekten-Vereins*, compressed air at a pressure of 400 to 1,500 mm. of mercury was introduced into the gas intake. Where temperatures of more than 1,200 deg. Cent. have to be reached it is necessary to pre-heat the air. Drum and ladle type furnaces are used. In the former the burners and outlets for the gases are so arranged that the latter are led axially through the drum. In the ladle type the gases are admitted tangentially. The gases are generally led into the furnace by two burners and flow in a circular direction. For both types the burners must ensure proper admixture of air and gas. The waste gases of the furnace are used for pre-heating the pots which receive the molten metal, and generally transmit their heat to air-heaters made of gas piping. In the case of a furnace intended for a charge weighing 700 kilos. and of melting point between 1,300 deg. and 1,360 deg. Cent., the consumption is 36 cubic metres of gas for every 100 kilos. of metal. The time for pre-heating is 15 minutes, charging occupies 20 minutes, and melting down 2½ hours. The temperature of the gases of combustion is 1,390 deg. to 1,440 deg. Cent. In the furnace, 1,250 deg. Cent. when entering the blower heater and 330 deg. to 360 deg. Cent. when leaving the heater. The compressed air is heated to 295 deg. Cent. Except for repairs to the masonry, no other repairs were necessary to the furnace under discussion, although it had been running since June, 1916. The fuel costs for 100 kilos. of charge are Kr. 5.20.

"Tetraphosphate" of Lime

The scarcity of superphosphate of lime has led to the commercial exploitation of the so-called "tetraphosphate" of lime or "tetra" invented by Prof. Stoppani of Bologna in 1911. It is made by heating to 600–700°

C. finely ground natural phosphate with 5–6 per cent. of a mixture of calcium, magnesium, and sodium carbonates. The calcined mass is moistened and then diluted with earth or sand until its content of phosphoric acid is reduced to about 20 per cent. According to the Canadian Trade Commissioner in Milan, the material is being manufactured in Italy at the rate of 50,000 metric tons per annum, and large plants are being erected near Luxor on the Nile and at Kosseir on the Red Sea. The Italian Ministry of Agriculture reports that it is equal to superphosphate in fertilising power, and that it has the advantage over the latter in being cheaper to produce. The French Government has recently sent an expert to Italy to investigate the process and to experiment. In an article in the *Bulletin de la Société d'Encouragement* (March-April), M. Hutier points out that the mode of manufacture seems to preclude the occurrence of chemical reaction between the ingredients, and asks if the results obtained are not due to the magnesias, lime and soda added. He deprecates further manufacture until this question has been answered. A writer in *Handel und Industrie* (No. 1396) takes the same view.

Equality of Man

In *Mind* (n. s., Nos. 107 and 108) W. M. Thorburn discusses the rights and wrongs of a person in language which is more vehement and impelling than is usual in philosophical papers. He contends that, in spite of the teaching of astronomers and biologists, men will persist in looking upon the "bimane biped" as the apex of all creation, the highest possible evolutionary form, and, as a corollary, estimate the life of any man as of more intrinsic value than the life of any animal. The quantity and not the quality of the human species is too commonly taken as the ideal. The result is a maudlin sentimentality which fears to face the problem of retribution as the necessary result of wrong-doing, and a futile belief that, by an adjustment of environment, equality among men can be maintained—a belief which is disproved by all the analogies of Nature and the lessons of history. Science is the fruit of leisure, and men of science can have the necessary leisure only if others less gifted are prepared to undertake work which is often called menial. The author's conclusion is a plea to consider whether democracy is leading. The whole discussion is provocative and stimulating, supported by a wealth of literary and scientific allusion, and will be valuable to thinkers in many fields of activity from speculative philosophy to the most practical science. Many will disagree with his conclusions, but his point of view is one which ought to be realised and honestly faced.—*Nature.*

Monel Metal

The constituent metals of Monel metal are present in the proportions occurring in the original ore mined at Sudbury, Canada. Analyses of the rolled bar give approximately 66% Ni, 30% Cu, 3.5% Mn + Fe, 0.13% Si, with small amounts of phosphorus and sulphur; and metal for casting contains 1 to 1.5% Si. The structure of Monel metal is that of a solid solution, the rolled bar showing sharply defined crystal grains, usually twinned. Mechanical tests on the rolled rod show a tensile strength of 39.2 tons; elongation on 2 in., 38.5%; reduction in area, 66.9%; Brinell hardness number, 174. When annealed at 800° C. the tensile test does not fall below 34 tons per sq. in., with a Brinell number of 143, and the strength is not dependent on the work applied. Monel metal possesses considerable strength at high temperatures; at 500° C., a temperature at which naval and manganese brass have no mechanical strength, the tensile strength is nearly 29 tons per sq. in. Casting of the metal is rendered difficult by the high melting point (about 1,360° C.) and the excessive shrinkage.—*Engineering.*

Some Compounds of Lead

By the addition of hydrogen peroxide to a solution of lead nitrate in 20% sodium hydroxide, a 40% yield of pure lead peroxide is obtained. Hydrogen peroxide at a dilution of 0.006 gm. per litre may be detected by the addition of a trace of an alkaline solution of a lead salt, and, conversely, lead at a dilution of 0.0025 gm. per litre may be detected by neutralising the solution, adding an excess of hydrogen peroxide, and then, drop by drop, a 1% solution of sodium hydroxide. Amorphous red lead is obtained by heating together equal weights of lead nitrate and 50% sodium hydroxide solution at 150° C., but if the amount of lead salt is halved and the temperature raised to 100° C. a microcrystalline red oxide is obtained (see also J. Chem. Soc., Jan., 1918).—*Note in J. Soc. Chem. Ind. on a paper by V. Zolier in Bull. Soc. Chem.*

The Trim of Ships*

Effects on Design and Use

It rarely happens that a ship floats so that the line of its keel is parallel with the surface of the water. In the draughting stages of a vessel it is necessary to assume a definite position of the former in relation to the latter. In the majority of cases drawings of a vessel are made out so that the line of keel is parallel with the waterline, but it often happens that the line of keel is raked, that is to say, sloped in relation to the waterline, and the difference between the draught with the raked keel line at the bow and the stern is called the rake of keel. When the ship is floating, the keel line will be parallel with the surface of the water or will take up its definite rake only if the weight of the vessel and the weight of the water displaced by her form an exact balance. With the ship floating, if a weight in her be carried from one position to another, say from forward to aft, the draught will decrease at the bow and increase at the stern. The ship is then said to change trim, and in this particular instance—since the draught is increased at the stern—she is said to have received a change of trim by the stern. The reverse process would produce a trim by the bow, or by the head. The trim of a ship is the excess difference between the draughts at her ends over the difference between the draughts when she is floating at normal trim, that is, on an even keel, which may be with the keel parallel with the waterline or at an angle with it determined by the rake already fixed upon.

In the design stages of a ship the question of suitable trim is an important one. The problem is not so complicated in a warship as in a merchant vessel. In the former, the weight of the ship herself, with her machinery and outfit complete, is much greater than that of the maximum load she will ever have to carry; in consequence, if the trim is made satisfactory in the light condition it is not very difficult to arrange matters so that it shall be so in the varying loaded states. With a merchant vessel, however, the weight of the ship complete is usually equal to, or even much less than, the weight of the load she will carry. With such a large portable load it is possible and even probable that the trim of a merchant vessel will vary very considerably from the light to the loaded condition.

TRIM WHEN LOADED.

In a ship carrying a large amount of cargo it invariably happens that a good deal more space forward of the machinery space is available for this purpose than aft of it. Shaft tunnels and tunnel recesses must be provided at the after end of the ship, and these detract from the space available for cargo, whereas the forward holds are usually quite clear. In addition, the forward sections are fuller in the lower parts of the ship than those aft. This increased capacity of the forward end causes the vessel to trim by the bow as she takes in cargo. In many cases this effect is so marked that a homogeneous cargo throughout the ship will make her trim by the head and very often to an undesirable extent. This can be remedied by the carriage of water ballast aft, but, should the vessel be loading down to her Plimsoll mark, this water ballast represents a loss in cargo deadweight.

The extent of this trim by the head naturally depends upon the fore and aft position of the machinery spaces, and also on the relation of the average weight of the cargo per foot run of ship, to the average weight of the machinery per foot run. Generally speaking, if the machinery is moved forward it results in a transference of cargo from the forward to the after end of the vessel, and the trim would be improved in the loaded condition. There is a disadvantage in this procedure in that the shaft tunnels are lengthened, and the space occupied by them, together with the broken stowage in the after hold, decreases the total cubic capacity of the ship.

Some latitude of trim in the loaded condition may be obtained by the judicious disposition of alternative passenger and cargo spaces. If such spaces are provided at the after end of the ship, some one or more of them may be used for the carriage of cargo while those forward are used for passengers. The extra weight carried aft will go a long way towards decreasing the trim of the ship by the bow in the loaded condition. An example may be given to show the effect of these trim considerations. A vessel 500ft. long was built for a mixed cargo and passenger trade. The trim by the stern in the light condition was about 10ft., but, in spite of that, the trim by the bow in the fully-loaded condition with homogeneous cargo was as much as 16ft. This, of course, would be quite an impossible trim, but it was considerably improved by the expedient men-

tioned in the foregoing paragraph. With two compartments in the after 'tween decks carrying cargo instead of passengers, the trim by the bow was reduced to 4ft. in the loaded condition.

DOCKING AND TRIM.

It is safe to say that practically all merchant vessels trim by the stern when they are in the light condition. This must be so in order to counteract the forward trimming effect of the cargo. It may be thought at first sight that a ship might be designed to have a trim by the stern sufficient to ensure that the vessel will not trim by the bow when the cargo is added. Another consideration enters here. The trim of the light ship by the stern must not be too large if the vessel is to be safely docked. Safe docking resolves itself into a matter of safe stability. The stability of merchant vessels in the light condition varies very considerably, but it is sufficient for the present purpose to remember that the stability must not be negative while the ship is settling down on the blocks in the dock, and, further, should have a positive value. When a ship trimming by the stern enters dock, the sternpost first touches the blocks as the water leaves the dock. The bow then gradually settles down until the whole keel is in contact. This settling down is equivalent to a change of trim, and is brought about by the upward pressure of the blocks on the sternpost. The force so exerted tends to capsize the vessel, and has its greatest value just as the stem of the ship touches the blocks. The virtual stability of the vessel, therefore, is less than she possesses when floating freely, and the stability in this latter condition should be such as to allow of this reduction and still leave a positive value.

There is no simple ready-made formula by which this loss of stability can be calculated, but if the hydrostatic particulars of the ship are available it is not a difficult matter to estimate it. For many of the older vessels, however, such particulars are not available, and cases are on record of ships slipping off the blocks owing to lack of stability, and capsizing in the dock, generally causing serious damage. Although the processes are the same whether the vessel is docking or undocking, except that they take place in reverse order, it is worth nothing as a practical point that accidents of this nature usually happen when the vessel is undocking. When a ship is being docked, as soon as the sternpost touches the after-shores are put in position and lightly secured while the ship is settling down. On the other hand, on undocking, as soon as the keel begins to lift forward she may loosen the shores, and if the upward pressure at the after end is sufficient to overcome the stability of the vessel an accident might happen.

Many vessels cannot be safely docked in an absolutely light condition on this account. In such cases the usual method of procedure is to add weight forward and low down in the vessel, which serves the double purpose of increasing the stability and decreasing the trim by the stern, so that on taking the blocks she loses less stability and has a bigger quantity to draw from. This is usually effected by putting water in the ballast tanks of the forward part of the vessel, but in some cases the stability of a ship is so small in the light condition, often being negative, that this expedient in itself is not sufficient, and it is necessary to leave some cargo in the forward holds or coal in the forward bunkers. Deep tanks forward have been sometimes used for this purpose.

It may be argued from the foregoing that all vessels should be provided with a large amount of stability in the light condition, but another consideration enters here, in that the stability in the loaded condition might be so much as to make the vessel unduly stiff. It is all a matter of compromise, and should be carefully considered when a vessel is designed. That it has not been done so in the past is borne out by the difficulties that are met with in certain vessels already referred to.

RUNNING AND TRIM.

Trim by the bow must be avoided as far as possible, and generally all vessels should run with a trim by the stern. The latter increases the freeboard forward and gives good propeller immersion, as well as improving the steering. When a vessel runs in water the depth of which is limited particular attention must be paid to the trim. Shipowners whose vessels must run in shallow water often specify the maximum draught which must not be exceeded on any account, the mean draught not being so important in such a case. It often happens that seagoing vessels must enter harbors or rivers where the draught is limited, and to do so it

may be necessary to bring them to a level keel. In some cases information is supplied to the ship's officers, so that they can estimate exactly how to dispose of their weights, or how to introduce water ballast to bring the vessel on a level keel.

DEADWEIGHT AND TRIM.

There is one interesting feature in connection with the trim of ships which is generally overlooked. When the deadweight scale of a ship is being constructed it is generally worked out for the vessel on an even keel. Actually in practice, as has already been noted, a vessel will usually run down by the stern. The Plimsoll mark is placed at or about amidships, and the vessel can be loaded down to this mark, whatever her trim may be. If she is trimming by the stern, her form will usually be such that her displacement is actually greater than if she were on an even keel, and in consequence more deadweight can be carried in this condition. If she is trimming by the bow, the reverse is the case and less deadweight can be carried. Taking the case of the 500ft. ship already mentioned, she would gain as much as 75 tons in deadweight if she were trimming about 8ft. by the stern, a not inconsiderable quantity.

The amount of deadweight that may be carried when a vessel is loaded down to her Plimsoll mark can also be increased if attention is paid to the manner of loading. A ship is an elastic structure, and if the endmost holds and 'tween decks are loaded first the vessel will "hog," that is, take up a curve concave to the surface of the water. As the remaining holds are filled up, this "hog" does not entirely disappear, so that when she is fully loaded down the ends of the vessel are deeper in the water than the draught at the Plimsoll mark amidships would indicate. Actual figures for this have been given to show that there may be a gain of as much as 100 tons in a 500ft. ship.

A good deal of error can be introduced when measuring the quantity of water or other liquids in tanks while the vessel has a trim. These quantities will be different for the same soundings taken when the vessel is on an even keel, the condition for which the tanks are calibrated. Quite appreciable errors may be introduced in this way, and if accurate work is necessary account should be taken of the position of the sounding pipes in conjunction with trim and list of the vessel.

Curious Case of Absence of Sensation

AN interesting case of complete absence of sensations from skin receptors, and of some other special senses, is described in the *Lancet* of October 19. The senses absent are touch, both superficial and deep, pain, heat and cold, muscular sense, taste, and smell. The state has been present for twenty years, but the subject possesses more than the average intelligence. In the absence of guidance from the eyes, he is unable to make any movement as requested, saying that he has no knowledge of whether he is making any movement or not. On the other hand, the more automatic movements of walking and swimming, not requiring conscious co-operation, can be executed correctly without the eyes. It is also clear that the proprioceptive mechanism of the muscles is intact, since, with eyes closed, the limbs can be placed by another person in any position and remain there (Sherrington's "plastic" phenomenon), although the patient is unaware of what position he is in. With visual control, all movements are perfectly normally executed. The subject is ignorant of any feelings of fatigue, and seems to be devoid of most forms of emotion. He has no love of country or of home, and makes neither friends nor enemies. Nevertheless, he is an efficient soldier, and always willing to help in hospital work.

Detection of Hook Worm Disease

THE *Indian Journal of Medical Research* for July (vol. vi., No. 1) contains an excellent summary by Lt.-Col. Clayton Lane on methods, old and new, for the detection of hook-worm (ankylostome) infection. Concentration of the ova of the parasite in the dejecta may be effected by straining and centrifuging, and also by a "levitation" method. In the latter the centrifuged deposit is placed on a slide in a little water and allowed to stand for five minutes. At the end of this time the slide is carefully immersed in water and then taken out. By this procedure particulate matter is largely removed, but the hook-worm ova are sticky and adhere to the slide. The exact technique is described, and the method is applicable for parasitic ova other than those of the hook-worm.

*Engineering Supplement of the *London Times*.

Photographic Copying

No branch of photographic work calls for a sounder knowledge of the art than the copying of photographs, documents, pictures, and the like, and this is more especially the case when the work has to be done with such appliances as are usually found in an ordinary studio.

There are many points to be observed if the best possible result is aimed at, one of the most difficult problems being properly to estimate the actinic values of the image and its support respectively. If we take an old albumenized print made forty or fifty years ago, we shall probably find that it consists of a purplish image upon a yellow ground, varying from a deep cream to a full cheese color. Here the temptation is to under-expose, through fear of over-exposing the image, but it must be allowed that, no matter what happens, sufficient exposure must be given to allow the high-lights of the subject to develop up to a reasonable density. With experience it is possible to estimate exposures of such subjects with great accuracy, but the inexperienced copyist will do well to sacrifice a small plate in making a strip test, as is usually done in bromide printing. If only a quarter-plate be used upon a portion of a 12 x 10 subject it will suffice, four exposures of an inch wide may be made, and ratios of one, two, four, and eight times given. For the benefit of those not accustomed to strip exposures we may say that the best method is not to pull out the slide one inch at a time, but to open it fully and to push it in step by step. Thus, supposing that the shortest exposure likely to be of any use is estimated at ten seconds, we open the slide fully and give this exposure; then we cap the lens, push in the shutter so that one inch of the plate is covered (this may be arranged for any size of plate by making pencil lines upon the inner surface of the shutter), and giving a second exposure of ten seconds; successive exposures of twenty and forty seconds are made in the same way, great care being taken not to disturb the camera. We have now exposures of ten, twenty, forty, and eighty seconds upon the same plate, and these should be fully developed, no notice being taken of the appearance of the image until it is fixed. It will now be easy to deduce the proper exposure from the appearance of one or other of the sections. It may be that the strip with twenty seconds is a little too thin, and that with forty too dense; hence we should say that thirty seconds will give the best result. Or even the ten-second one may be too dense, or the eighty-second one too thin; in these cases the appearance of the image should give sufficient indication as to the reduction or increase of exposure which will be necessary.

Another point on which sufficient care is not exercised is the illumination of the surface. Many photographers think that it is only necessary to avoid reflections from the surface of glossy prints and glass-covered pictures, but this is not the case. Any gelatine coated paper has sufficient surface reflection to degrade the shadows if improperly lighted, and it may here be said that much may be done to cut out these surface reflections by using a color-sensitive plate and a yellow screen, even if the nature of the subject does not seem to call for it. By reducing the effect of the surface-reflections the yellow screen also helps to remove the great bogey of the copying "grain." Most copies show a great deal more of the texture of the original paper than was apparent to the eye, and this can only be overcome by proper lighting. The process engraver has an ideal method of illuminating his originals by using two arc lamps, one on either side of the original, and by this means he eliminates the little shadows which are the cause of the trouble. It is a curious fact that many copies are spoilt by "grain" through the use of a large camera and a short-focus lens. The effect of these is to cut off nearly all the front light which would fall upon the original, and to leave only side light to do the work. It is a good exercise to take a print on linograph paper and to make a negative in which the grain is hardly visible. There is one kind of grain which cannot be eliminated, viz., that caused by fine cracks in the albumen surface which have got filled in with dirt. All that can be done with these is to copy with a soft-focus lens or to interpose a thickness or two of thin celluloid between the negative and paper when printing.

The development of copy negatives requires to be done rather differently from ordinary direct portrait work. With a copy the image appears practically even all over the plate at the start, and not in stages, as in portraits, where the white collar, the face and hands, and the clothing, appear at appreciable intervals after each other. With a copy of the same subject the image would come up on a level, and the operator is apt to think that the plate is over-exposed, and to commit the error of stopping before proper density is obtained. This appearance is due to the slight surface-reflections

we have already mentioned. In the original the black shadows of the coat are representations of black cloth on which no light is falling, in the copy they are representations of a piece of paper covered with a layer of dark silver particles, the surfaces of which receive exactly as much light as the high-lights of the picture. Therefore we must take care to give as nearly as possible the correct exposure, and then to develop fully, so as to secure sufficient contrast and avoid the flatness to which the superficial nature of the original would naturally tend.

The choice of a plate for copying is an important question. Some operators assert that they can make as good copies on their regular portrait plates as upon any other. This may be so with certain subjects, but with badly faded originals a variety of speed and quality is essential. Although it may seem paradoxical, the best results from very flat and faded originals can often be obtained upon "process" plates in spite of the yellowness of the ground, and such plates should always be used for line subjects, letters and the like. Ortho plates with a yellow filter are absolutely necessary for most colored subjects. A plate which does not give density readily is not usually much good for this class of work, therefore "ordinary" plates are always to be preferred to more rapid grades. There is no disadvantage in using an orthochromatic plate for any class of work, even without a screen. There will be practically no difference in the color rendering unless a screen be used, so that there is no necessity to stock ordinary and "ortho" plates of the same speed.

A last note of advice we would give the beginner in copying is not to try experiments on a rush job, but to work at leisure when a failure can be investigated, and a second trial made without delaying the execution of the order.—*Brit. Jour. Photog.*

Preventing Growth in Grey Cast Iron

A METHOD for the prevention of growth in grey cast iron was suggested before the Iron and Steel Institute by Mr. J. E. Hurst.

He pointed out that the phenomenon of growth or expansion of grey cast iron when subjected to repeated heatings in an oxidizing atmosphere has been shown to be due to the increase in volume consequent on the internal oxidation of the various constituents by means of the gradual penetration of the oxidizing gases into the mass, and the primary cause is the presence of free graphite plates which permit the entry and penetration of these gases. Hence the removal of the free graphite from the exterior surface layers would appear to be an ideal method of prevention, amounting to the production of a skin or "case" of decarbonized material. This method was successfully employed in the case of grey cast iron water pipe, which was repeatedly maintained at a temperature in the region of 800 and 900 deg. C. alternately for a considerable period in a strongly oxidizing furnace atmosphere. The pipe was covered with a thick scale of rust (hydrated ferric oxide), which is considered to have contributed largely to the decarbonization. In other experiments the author met with success by prolonged annealing in this material.

This method, the author suggested, should find application in the protection from growth of dies and permanent moulds for iron and non-ferrous metals, and of valve seatings and guides in internal combustion engines. He has several permanent moulds that have been protected by annealing at 900 to 950 deg. In ordinary brown rust (oxide of iron) for 2 hours, and improved results have been obtained by raising the annealing temperature to 975-1,000 deg., though in these cases troubles have been experienced through distortion.—*London Times Engineering Supplement.*

Improved Locomotive Service

ON some roads, and at some seasons, the number of locomotives under repair, and therefore out of service anywhere from a week to three months, has, not so long ago, been stated to have been from 30 to 50 per cent of the total equipment, indicating the necessity for radical changes in methods for maintaining the mechanical efficiency of the roads. This number, it is stated has been reduced on some roads to about 10 per cent, which, applied to the whole number of locomotives in service, would be equivalent to the addition of 3 325 locomotives. Whether this low average can be maintained during the winter, when operating conditions are most severely strained is doubtful. In any case it is an enlightening commentary on the obsolete rule-of-thumb methods that have too often prevailed in the mechanical departments of too many railroads. A man may be a first class blacksmith, but that does not qualify him for the position of mechanical superintendent.

Docking a Dock

THE floating dock of the Gota yard at Gothenburg, which is the largest in Scandinavia, has just undergone a somewhat peculiar test, inasmuch as the Eriksberg floating dock has been docked in it, and in the Eriksberg dock there was at the time a fairly good-sized tugboat, which remained in the latter dock during its towing to the Gota yard. Both the dock and the tugboat had to be overhauled, and the latter was to undergo a number of repairs, both of which jobs proceeded simultaneously. The Eriksberg dock can accommodate vessels up to 3,200 tons, the Gota yard floating dock being large enough to receive the Swedish-American liner "Stockholm." The latter dock can dock itself, being so constructed that two parts can dock the third.—*Engineering.*

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Table of Contents

	PAGE
The Chemistry of Flavoring Matters—II.—By F. Barral and A. Ranc.	114
The Skoda Works.	115
Lead Alloys.	115
Embroidery by Wholesale.—5 illustrations.	116
Diffraction Phenomena of Cultures of Micro-Organisms.	116
A Museum as a Laboratory.	117
Determination of the Adhesiveness of Glue.	117
The Pleistocene Man of Vero, Florida.—By F. H. Stiers.	118
Titanium and Rutile.	119
The Camelidae of the New World.—By Edward Albee.—0 illustrations.	120
Annealing Aluminum.	123
Big Mercury-Vapor Rectifiers.	123
Action of Laundry Agents on Textiles.	123
Manufacture of Charcoal as an Economic Measure.—By Helge Sylven.—5 illustrations.	124
Spitzbergen's Minerals.	126
Gas Fired Melting Furnaces without Crucibles.	126
Tetraphosphate of Lime.	126
Equality of Man.	126
Monel Metal.	126
Some Compounds of Lead.	127
The Trim of Ships.	127
Curious Case of Absence of Sensation.	127
Detection of Hook Worm Disease.	127
Photographic Copying.	128
Improved Locomotive Service.	128
Docking a Dock.	128

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14
15
15
16
16
17
17
18
19

20
23
23
23

24
26
26
26
26
26
27
27
27
28
28